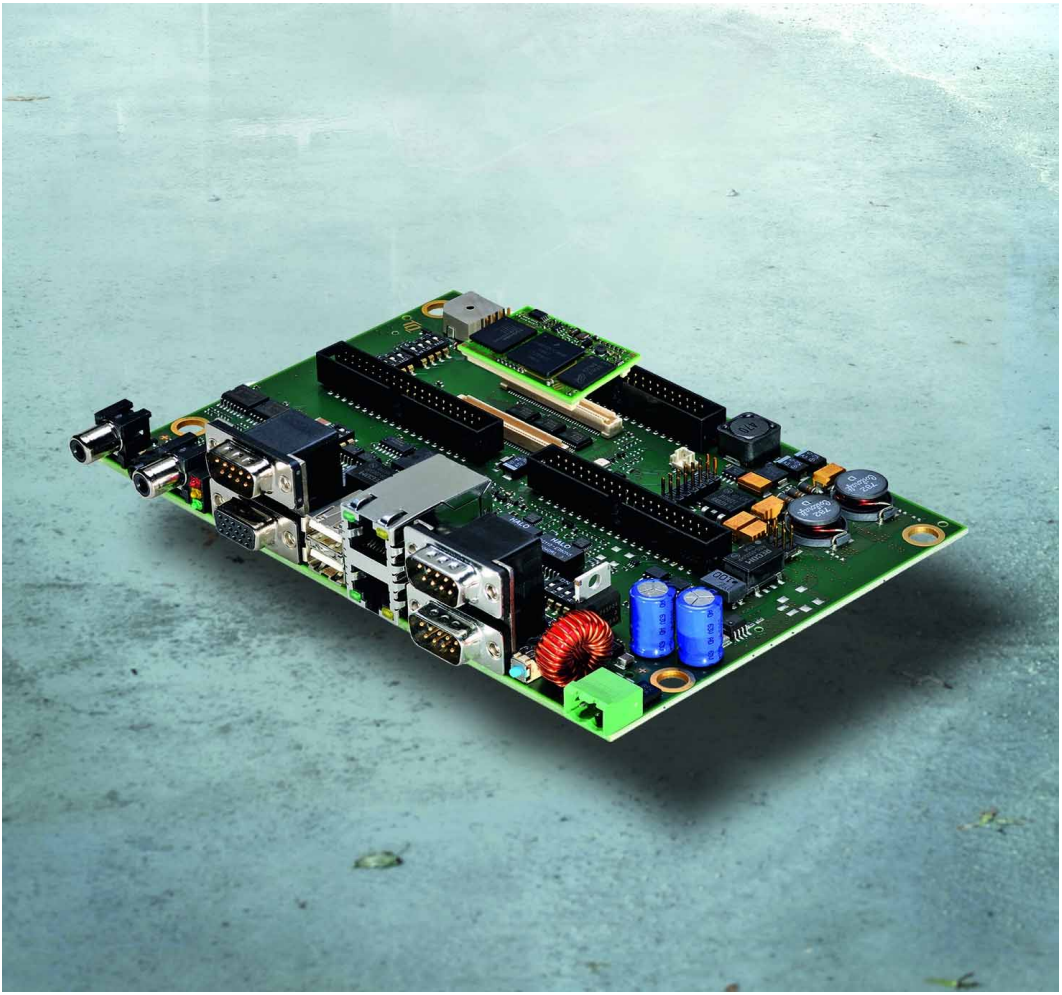
STK-MBa28
User's Manual

STK-MBa28 UM 102
11.11.2011



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Revision history

Rev.	Date	Name	Pos.	Modification
100	23.05.2011	Petz		Document created
101	14.07.2011	Petz	Illustration 34 Table 33 Table 35	Replaced Order code revised Pin assignment revised
102	11.11.2011	Petz	All	Completely revised

1. ABOUT THIS MANUAL

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1.4 Imprint

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1.5 Symbols and typographic conventions

Table 1: Terms and conventions

Symbol	Meaning
	This symbol represents the handling of electrostatic-sensitive modules and / or components. These components are often damaged / destroyed by the transmission of a voltage higher than about 50 V. A human body usually only experiences electrostatic discharges above approximately 3,000 V.
	This symbol indicates the possible use of voltages higher than 24 V. Please note the relevant statutory regulations in this regard. Non-compliance with these regulations can lead to serious damage to your health and also cause damage / destruction of the component.
	This symbol indicates a possible source of danger. Acting against the procedure described can lead to possible damage to your health and / or cause damage / destruction of the material used.
	This symbol represents important details or aspects for working with TQ-products.
`Command`	A font with fixed-width is used to denote commands, file names, or menu items.

1.6 Tips on safety

Improper or incorrect handling of the product can substantially reduce its life span.

1.7 Handling and ESD tips

General handling of your TQ-products

	The TQ-product may only be used and serviced by certified personnel who have taken note of the information, the safety regulations in this document and all related rules and regulations. A general rule is: do not touch the TQ-product during operation. This is especially important when switching on, changing jumper settings or connecting other devices without ensuring beforehand that the power supply of the system has been switched off. Violation of this guideline may result in damage / destruction of the module and be dangerous to your health. Improper handling of your TQ-product would render the guarantee invalid.

Proper ESD handling

	The electronic components of your TQ-product are sensitive to electrostatic discharge (ESD). Always wear antistatic clothing, use ESD-safe tools, packing materials etc., and operate your TQ-product in an ESD-safe environment. Especially when you switch modules on, change jumper settings, or connect other devices.

1.8 Naming of signals

A hash mark (#) at the end of the signal name indicates a low-active signal.
Example: RESET#

If a signal can switch between two functions and if this is noted in the name of the signal, the low-active function is marked with a hash mark # and shown at the end.
Example: C / D#

If a signal has multiple functions, the individual functions are separated by slashes when they are important for the wiring.
The identification of the individual functions follows the above conventions.
Example: WE2# / OE#

1.9 Further applicable documents / presumed knowledge

- **Specifications and manual of the used modules:**
  These documents describe the service, functionality and special characteristics of the used module (incl. BIOS).

- **Specifications of the used components:**
  The manufacturer's specifications of the used components, for example CompactFlash cards, are to be taken note of.
  They contain, if applicable, additional information that must be taken note of for safe and reliable operation.
  These documents are stored at TQ-Systems.

- **Chip errata:**
  It is the user's responsibility to make sure all errata published by the manufacturer of each component are taken note of.
  The manufacturer's advice should be followed.

- **Software behaviour:**
  No warranty can be given, nor responsibility taken for any unexpected software behaviour due to deficient components.

- **General expertise:**
  Expertise in electrical engineering / computer engineering is required for the installation and the use of the device.

1.10 Acronyms and definitions

The following acronyms and abbreviations are used in this document:

Table 2: Acronyms

Acronym	Meaning
AC	Alternating Current
AD	Address/Data
AD	Air Discharge
ADC	Analog/Digital Converter
ARM®	Advanced RISC Machine
BIOS	Basic Input/Output System
CAN	Controller Area Network
CD	Card Detect
CD	Contact Discharge
CPU	Central Processing Unit
DC	Direct Current
DIN	Deutsche Industrie Norm
DIP	Dual In-line Package
DUART	Dual Universal Asynchronous Receiver/Transmitter
EEPROM	Electrically Erasable Programmable Read-Only Memory (Byte-wise re-writable)
EGB	Elektrostatisch Gefährdete Bauelemente
EMC	Electromagnetic Compatibility
eMMC	Embedded MultiMediaCard (Flash)
EN	Europäische Norm
ESD	Electrostatic Discharge
FET	Field Effect Transistor
FFC	Flat Flex Cable
GPI	General Purpose Input
GPIO	General Purpose Input/Output
GPO	General Purpose Output
I/O	Input/Output
I/P	Input/Power
IEEE	Institute of Electrical and Electronics Engineers
IP00	Ingress Protection 00
I^2C	Inter-Integrated Circuit
I^2S	Inter Integrated Circuit Sound
JTAG	Joint Test Action Group

Table 2: Acronyms (continued)

Acronym	Meaning
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LS	Low Speed (USB: 1.5 Mbit/s)
LSB	Least Significant Bit
LVDS	Low Voltage Differential Signal
MB	Main board
MMC	Multimedia Card
MOZI	Module extractor (Modulzieher)
NC	Not Connected
O/P	Output/Power
OTG	On-The-Go
PCB	Printed Circuit Board
PD	Pull-Down (Resistor)
PHY	Physical (Interface)
PU	Pull-Up (Resistor)
PWM	Pulse Width Modulation
RCA	Radio Corporation of America
RFU	Reserved for Future Use
RGB	Red Green Blue
RJ	Registered Jack
RS232	Recommended Standard (serielle Schnittstelle)
RTC	Real-Time Clock
RoHS	Restriction of (the use of certain) Hazardous Substances
SD	Secure Digital
SDHC	Secure Digital High Capacity
SPDIF	Sony-Philips Digital Interface Format
SPS	Speicherprogrammierbare Steuerung ⇨ Programmable Logic Controller (PLC)
STK	Starterkit
THD+N	Total Harmonic Distortion + Noise
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
VGA	Video Graphics Array (640 × 480)
WEEE	Waste Electrical and Electronic Equipment
WP	Write-Protection

2. BRIEF DESCRIPTION

The STK-MBa28 is designed to be driven by the TQ-module TQMa28, which is based on the Freescale ARM-CPU MCIMX287 (i.MX28). In combination with a module and a display with touchscreen it offers PC core functionalities and standard interfaces.
By using the functionalities of the Starterkit STK-MBa28 this main board forms together with the TQMa28 a modular system to develop own product ideas.

3. TECHNICAL DATA

3.1 System architecture and system functionality

3.1.1 Block diagram

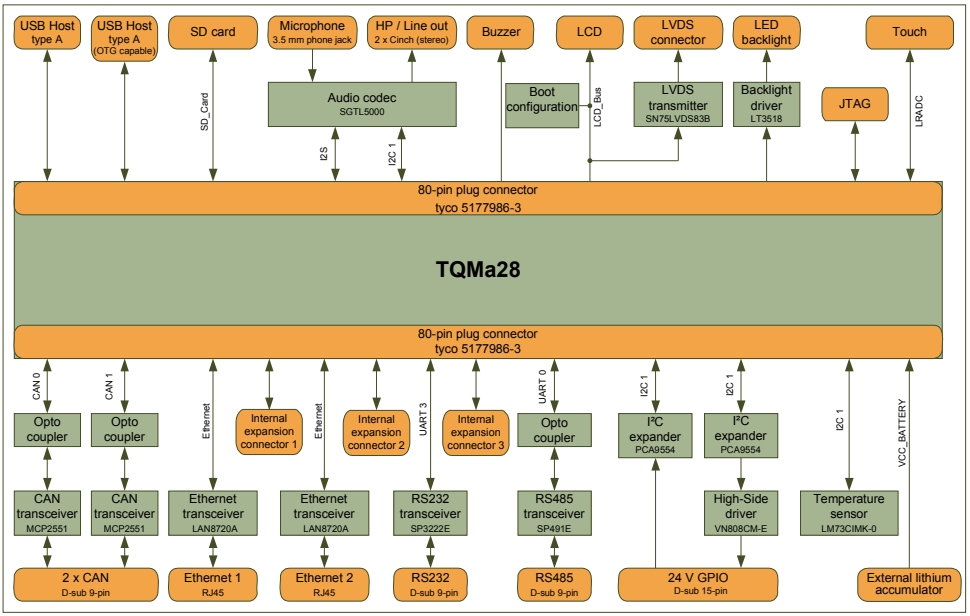

Illustration 1: STK-MBa28 block diagram

3.1.2 Technical data electronics

The interfaces and system components listed in the following are implemented on the STK-MBa28. Due to the fact that the STK-MBa28 can be installed in a casing the interfaces are divided into external and internal interfaces.

3.1.2.1 External interfaces

- 2 × Ethernet 10/100 Mbit
- 1 × RS485
- 1 × RS232
- 2 × CAN
- 1 × USB 2.0 Hi-Speed host interface
- 1 × USB 2.0 Hi- Speed host interface (On-the-Go capable)
- 1 × GPIO (8 × OUT / 4 × IN)
- 1 × SD card
- 2 × Audio output
- 1 × Microphone input
- 1 × Power supply

3.1.2.2 Internal interfaces

- 1 × TQMa28
- 1 × JTAG
- 2 × LCD (model dependent)
- 2 × LCD backlight (model dependent)
- 3 × touchscreen (model dependent)
- 1 × LCD via LVDS (optional)
- 1 × Power-on push button
- 3 × Headers for specific extensions
- Connector for accumulator

3.1.2.3 User's interfaces

- 1 × Reset push button
- 3 × Status LED (external) User-LED 1, User-LED 2, Power-LED
- 4 × Status LED (internal) Reset-LED, USB_OC-LED 1, USB_OC-LED 2, front Power-LED
- 4 × DIP switch
- Buzzer

3.1.2.4 System components

- Temperature sensor
- Internal power supply
- Voltage supervision and reset concept
- I^2C bus

3.1.3 Technical data mechanics, design

Dimensions PCB (W × D × H):	175 × 120 × 2 mm^3
Overall dimensions (W × D × H):	175 × 130 × 32 mm^3 (app.)
Weight:	248 g

4. ELECTRONICS SPECIFICATION

4.1 External interfaces

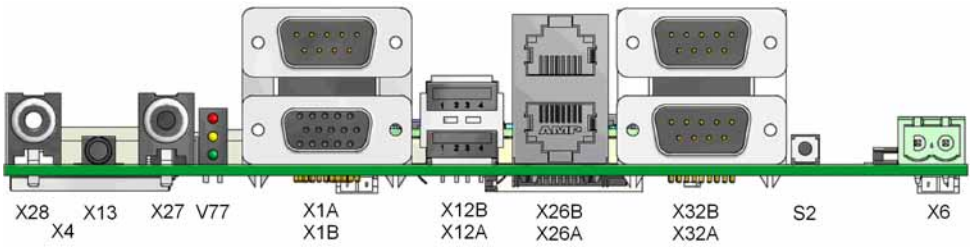

Illustration 2: External interfaces of the STK-MBa28

4.1.1 Function specification

4.1.1.1 Ethernet 1 (X26A)

The TQMa28 directly drives the Ethernet 1 interface. The SMSC LAN8720A is used as PHY. IEEE1588 frames are supported. The 1588-signals are accessible at plug connector X10 (see 4.2.3.9.1).

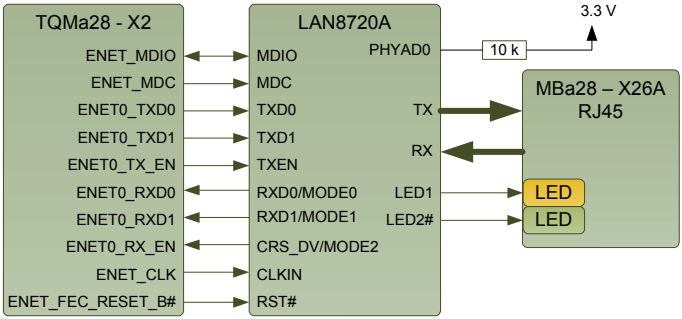

Illustration 3: Ethernet 1, block diagram

The LAN8720A offers the following modes:

Table 3: LAN8720A modes

Mode [0…2]	Function	Remark
000	10BASE-T	Half-duplex, autonegotiation off
001	10BASE-T	Full-duplex, autonegotiation off
010	10BASE-TX	Half-duplex, autonegotiation off
011	100BASE-TX	Full-duplex, autonegotiation off
100	100BASE-TX	Half-duplex start, autonegotiation on
101	100BASE-TX	Repeater mode, half-duplex start, autonegotiation on
110	Power down	Information in data sheet
111	**ALL capable**	**No determination, autonegotiation on, mode is preset in hardware**

This table does not replace the data sheet of the LAN8720A.

4.1.1.2 Ethernet 2 (X26B)

The TQMa28 directly drives the Ethernet 2 interface. The SMSC LAN8720A is used as PHY.

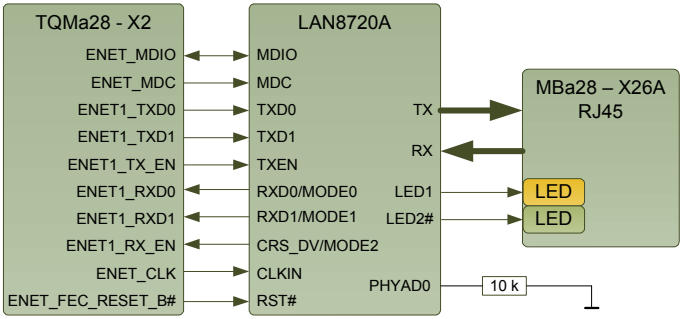

Illustration 4: Ethernet 2, block diagram

4.1.1.3 RS485 (X32A)

The AUART0 of the TQMa28 drives the RS485 interface of the STK-MBa28. The optocouplers Avago HCPL0631 and HCPL0601 are used for galvanic separation. The Recom RSS-0505/HP serves as the power supply for the galvanically separated part of the RS485 interface.
The Exar SP491EEN-L is used as RS485 transceiver.

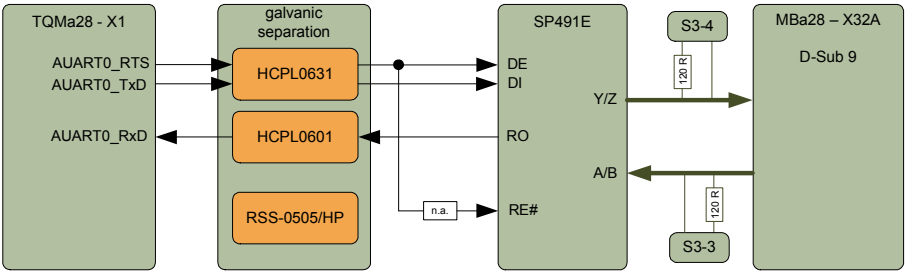

Illustration 5: RS485 block diagram

The RS485 signals can be terminated with 120 Ω with either DIP switch S3 or cable-sided by bridging pins 8 / 9 (RxD) and 1 / 7 (TxD). Details can be found in Table 67 on page 56.

4.1.1.4 RS232 (X32B)

The AUART3 interface of the TQMa28 drives the RS232 interface of the STK-MBa28 by default. The Exar SP3222EEA-L is used as a driver.

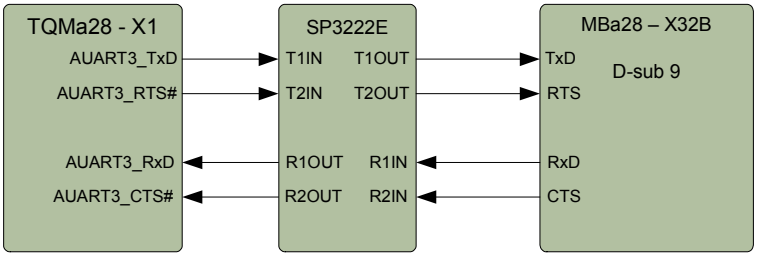

Illustration 6: RS232 block diagram

4.1.1.5 CAN 1/ CAN 2 (X1A)

The two CAN ports of the TQMa28 directly drive both CAN interfaces on the STK-MBa28. Optocouplers of type Avago HCPL0601 are used for galvanic separation. The Recom RTS-0505/P serves as the power supply for the galvanically separated part of the CAN interface. Microchip MCP2551T-I/SN are used as CAN transceivers.

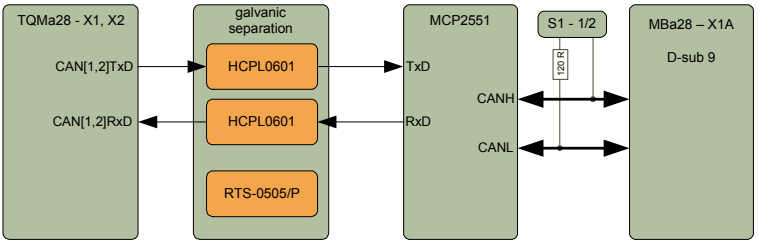

Illustration 7: CAN block diagram

The pinout of D-sub connector X1A can be found in section 4.1.3.4 on page 25.
The CAN signals can be terminated with 120 Ω by using DIP switch S1 (see Table 66 on page 56).

4.1.1.6 GPIO (X1B)

Eight GPIO outputs are made available via a high side driver VN808CM-E and four GPIO inputs are directly made available at an external plug connector.
A voltage of 24 V ±20 % at the GPIO plug connector serves as the power supply. As placement option the supply voltage of the STK-MBa28 can alternatively be used as the power supply. In this case the user has to ensure the correct level of the input voltage.

Two NXP (PCA9554D) 8 bit I²C bus I/O port circuits generate the GPIOs.
This circuit offers eight bidirectional GPIO ports, which can drive and sink 10 mA.
The I²C addresses of both I²C I/O ports are listed in section 4.4.2 on page 58.

The basic circuit of the GPIO connection on the STK-MBa28 is shown in Illustration 8.
The remaining four I/O ports are used to drive two user-LEDs (yellow and red) at V77, to switch on the backlight via plug connector X5 and to switch on the LVDS transmitter (LVDS display).

The pinout of D-sub connector X1B can be found in section 4.1.3.5 on page 26.

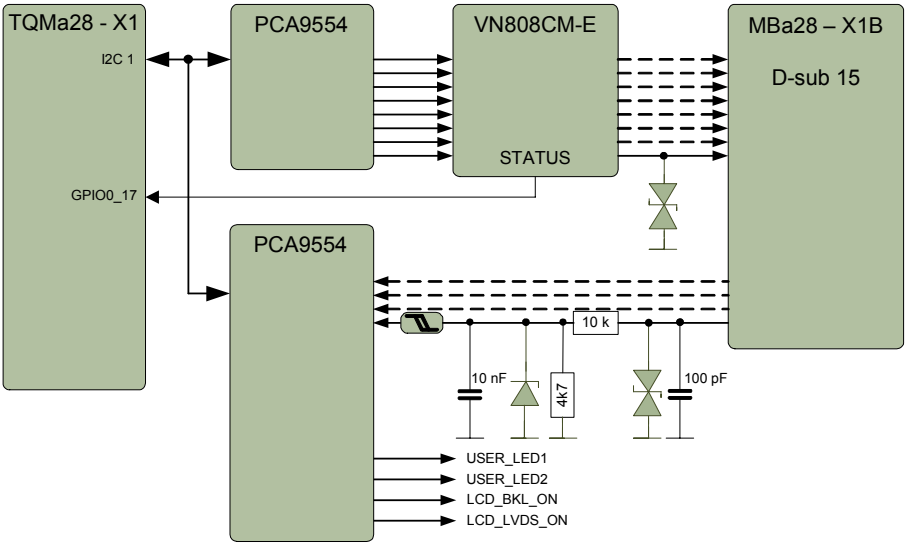

Illustration 8: GPIO block diagram

Table 4: Mapping of the GPIOs

Signal name at X1B	I^2C base address	I/O port	Direction
OUT0	0x20	IO0	O
OUT1		IO1	O
OUT2		IO2	O
OUT3		IO3	O
OUT4		IO4	O
OUT5		IO5	O
OUT6		IO6	O
OUT7		IO7	O
IN0	0x21	IO0	I
IN1		IO1	I
IN2		IO2	I
IN3		IO3	I
Signal name (internally used)		I/O port	Direction
USER_LED1		IO4	O
USER_LED2		IO5	O
LCD_BKL_ON		IO6	O
LCD_LVDS-ON		IO7	O

4.1.1.7 USB 2.0 Hi-Speed host (X12A)

The USB host interface of the TQMa28 (USB1) is routed directly to the USB-A jack X12A, including the protection circuit. The over-current protection is implemented with a Texas Instruments TPS2042B.

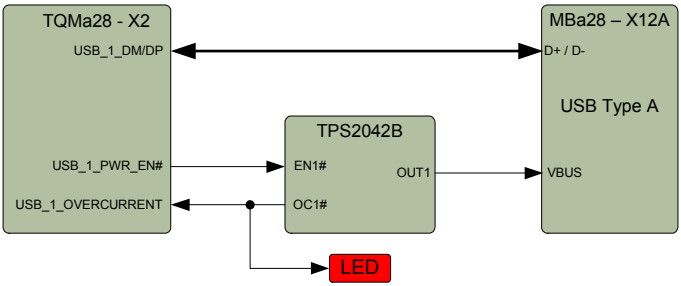

Illustration 9: USB host block diagram

4.1.1.8 USB 2.0 Hi-Speed host (X12B)

The USB OTG interface of the TQMa28 (USB0) is configured as host by default and cannot be connected to a PC as device.
To offer OTG functionality it is possible to assemble a USB-Mini-AB jack as a placement option. However, as a result both USB 2.0 Hi-Speed interfaces fall away.

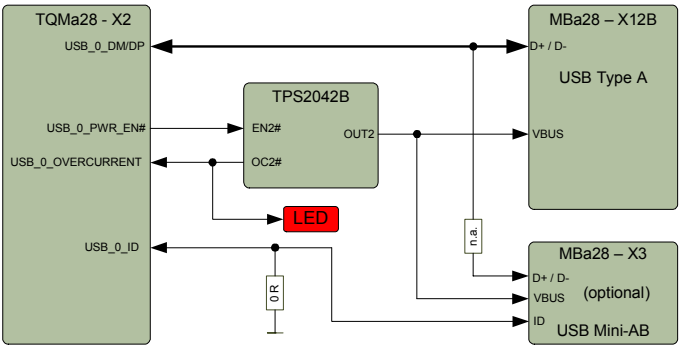

Illustration 10: USB OTG block diagram

4.1.1.9 Audio output right (X27) and left (X28), microphone input (X13)

The audio functionality is implemented with a Freescale SGTL5000 on the STK-MBa28.

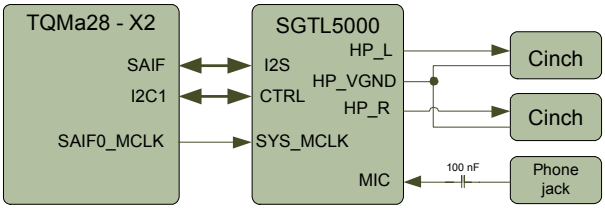

Illustration 11: Audio block diagram

The headphone signals HP_L/R can be switched off and the line out signals can be switched on at the cinch sockets as a placement option.
The SGTL5000 can be accessed via I^2C base address 0x0A.

4.1.1.10 SD card (X4)

The external SD card is connected to the SD_CARD bus of the TQMa28.

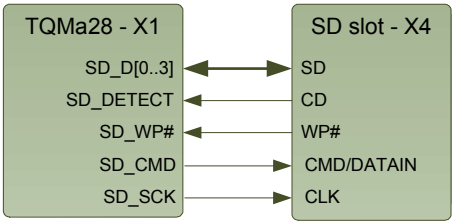

Illustration 12: SD card block diagram

4.1.1.11 Power-in (X6)

For protective and EMC reasons the supply input of the STK-MBa28 is designed very robustly.

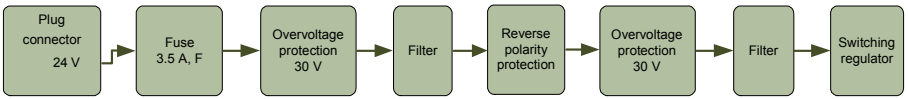

Illustration 13: Power-in block diagram

4.1.2 Electrical characteristics

4.1.2.1 Ethernet 1 (X26A)

Type of media:	10/100 Mbit
Signal characteristic:	Compatible with the IEEE-802.3 standard
Status LEDs:	2
Modes:	MDI, Auto-MDIX
Interface on module:	RMII / ENET0

4.1.2.2 Ethernet 2 (X26B)

Type of media:	10/100 Mbit
Signal characteristic:	Compatible with the IEEE-802.3 standard
Status LEDs:	2
Modes:	MDI, Auto-MDIX
Interface on module:	RMII / ENET1

4.1.2.3 RS485 (X32A)

Transfer rate:	Up to 4 Mbit/s (full-duplex)
Interface on module:	AUART0
Handshake:	RTS# used for clearing the transmission direction
Signal characteristic:	Compatible with the EIA/TIA-485 standard / galvanically separated
ESD protection:	±15 kV human body model

4.1.2.4 RS232 (X32B)

Transfer rate:	Up to 120 Kbit/s
Interface on module:	AUART3
Handshake:	RTS#/CTS# (via AUART3)
Signal characteristic:	Compatible with the EIA/TIA-232 standard
ESD protection:	±15 kV human body model

4.1.2.5 CAN 1/ CAN 2 (X1A)

Transfer rate:	Up to 1 Mbit/s
Interface on module:	CAN1 resp. CAN2
Signal characteristic:	Compatible with the ISO-11898 standard (CAN 2.0B) / galvanically separated
ESD protection:	6 kV human body model

4.1.2.6 GPIO (X1B)

Type of media: 24 V GPIOs (according to the SPS standard)
Interface on module: I2C1
Signal characteristic: see Table 5 / not galvanically separated
ESD protection: 600 W pulse power (10 / 1 ms, 0.01 % duty cycle)

Table 5: Electrical characteristics of the GPIs

Parameter	Min.	Type.	Max.	Unit
Input frequency (hardware limitation)			15	kHz
Input voltage V_{IN}	0		28	V
Input current (V_{IN} = 28 V)			2.5	mA
HIGH input level	6.9		V_{IN}	V
LOW input level	0		1.8	V

Depending on the operating system and its workload the maximum input frequency can be significantly lower than the value specified by the hardware.

Table 6: Electrical characteristics of the GPOs

Parameter	Min.	Type.	Max.	Unit
Output frequency			3	kHz
Supply voltage (V_{CC24V_EX})	12	24	30	V
Output voltage (depending on R_{Load})		<V_{CC24V_EX}		V
Load resistance R_{Load}	48			Ω
Load inductance (V_{CC24V_EX} = 24 V, R_{Load} = 48 Ω)			2	H
Output current of a single output			700	mA
Output current of all outputs together			5	A
Short circuit current (V_{CC24V_EX} = 24 V, R_{Load} = 10 mΩ)	0.7		1.7	A

4.1.2.7 USB 2.0 Hi-Speed host (X12A)

Type of media:	USB 2.0 Hi-Speed, 5 V bus voltage (limited to 500 mA)
Interface on module:	USB host physical
Signal characteristic:	Compatible with the Universal Serial Bus Specification Rev. 2.0
ESD protection:	±15 kV human body model

4.1.2.8 USB 2.0 Hi-Speed host (X12B)

Type of media:	USB 2.0 Hi-Speed, 5 V bus voltage (limited to 500 mA)
Interface on module:	USB OTG physically only host (cannot be used as device)
Signal characteristic:	Compatible with the Universal Serial Bus Specification Rev. 2.0
ESD protection:	±15 kV human body model

4.1.2.9 Audio output right (X27) left (X28)[1], microphone input (X13)

Audio outputs

SNR (–60 dB input):	98 dB
THD+N:	–86 dB
Load:	16 Ω
Power output:	58 mW

Microphone input

Input:	Mono
Gain:	Programmable (0, +20, +30, +40 dB)
Interface:	I^2S

4.1.2.10 SD card (X4)

Type of media:	SD / SDHC card
Interface on module:	SD 4-bit
Signal characteristic:	Compatible with the SD Host Controller Standard Specification version 2.0, support for high capacity SD memory cards

1 For the default assembly the following values are valid, but not for the optional line out assembly.

4.1.2.11 Power-in (X6)

Table 7: Electrical characteristics of the power supply

Parameter	Min.	Type.	Max.	Unit
Input voltage	15	24	30	V
Input current[2]		190		mA
Power consumption		4.56		W
Rated current of the fuse		3.5		A
Voltage drop in the fuse			0.13	V
Melting time of the fuse (t < 10 ms)		3.9		A^2s
Melting time of the fuse (I = 10 ∗ I_N)		3.3		A^2s

The specified standard power supply for the STK-MBa28 is the following:

- IPCX86MM NT REV. 100 ⇨ 18 V (max. 3.9 A)

With the abovementioned power supply the low voltage directives according to EN 60950 are met. In the case where another power supply is used or if the device is supplied from a 24 V power grid, it is the customer's responsibility to make sure the specified maximum ratings and standards are met.

Table 8: Overview of the function groups of the power supply

Parameter	Remark
Reverse voltage protection	Yes Actively via serial FET (max. 30 V for both polarities allowed).
Excess voltage protection	Yes, voltage limitation to 30 V. With lasting excess voltage the assembly can be damaged!
Short circuit protection	Yes Passive over current protection by soldered ceramic fuse.
Filter	Integrated filter for the power supply input.

2 The value depends on the software and is valid for an input voltage of 24 V.

4.1.3 Plug connectors and pin assignments

4.1.3.1 Ethernet 1 / 2 (X26A/B)

Table 9: Plug connector Ethernet 1/2 (X26A/B)

Manufacturer	Description
Tyco 6368011-3	• Type: 2 × RJ45 jack • Eight contacts each • LEDs: green and yellow • –40 °C to +80 °C

The following table shows the configuration of the plug connector for Ethernet 1/2 (X26A/B).

Table 10: Pin assignment plug connector Ethernet 1/2 (X26A/B)

Pin	Signal	Type	Remark
1	TX+	O	Galvanically separated
2	TX–	O	Galvanically separated
3	RX+	I	Galvanically separated
4	Termplane	–	75 Ω in series, AC coupled to DGND
5	Termplane	–	Connected to pin 4
6	RX–	I	Galvanically separated
7	Termplane	–	75 Ω in series, AC coupled to DGND
8	Termplane	–	Connected to pin 7
M	DGND	P	Ground housing
LED1	Link_Activity	–	Yellow: - shines when connection is established - blinks if ENETX_RX_EN is active
LED2	Speed_Indicator	–	Green: - shines only at a transmission of 100 Mbit

Two LEDs are used for diagnosis of the interface.

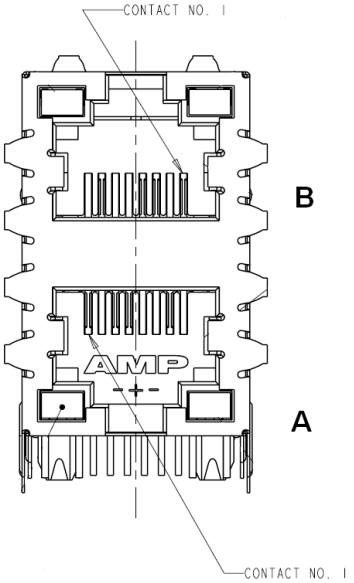

Illustration 14: Wiring of X26

4.1.3.2 RS485 (X32A)

Table 11: Plug connector RS485 (X32A)

Manufacturer	Description
Yamaichi DDP-011S1	• Dual standard D-sub connector • 9-pin male connector plug each • –55 °C to +105 °C

The following table shows the configuration of the plug connector for RS485.

Table 12: Pin assignment plug connector RS485 (X32A)

Pin	Signal	Type	Remark
1	RS485_Y	O	Non inverted output / galvanically separated
2	NC	–	Not connected
3	NC	–	Not connected
4	RS485_A	I	Non inverted input / galvanically separated
5	GND_S2	P	Ground / galvanically separated
6	RS485_Z	O	Inverted output / galvanically separated
7	120R_TX	–	Bridge to pin 1 for 120 Ω termination
8	120R_RX	–	Bridge to pin 9 for 120 Ω termination
9	RS485_B	I	Inverted input / galvanically separated
M	DGND	P	Ground housing

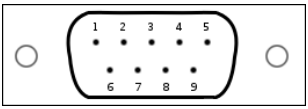

Illustration 15: Wiring of X32A

Attention: Destruction or malfunction!	
	Due to three physically identical 9-pin male D-sub connector plugs there is the danger of confusion between RS232, RS485 and CAN. The exact arrangement of the interfaces is shown in Illustration 2 on page 9.

4.1.3.3 RS232 (X32B)

Table 13: Plug connector RS232 (X32B)

Manufacturer	Description
Yamaichi DDP-011S1	• Dual Standard D-sub connector • 9-pin male connector plug each • –55 °C to +105 °C

The following table shows the configuration of the plug connector for RS232.

Table 14: Pin assignment plug connector RS232 (X32B)

Pin	Signal	Type	Remark
1	NC	–	Not connected
2	RS232_RXD	I	Receive Data
3	RS232_TXD	O	Transmit Data
4	NC	–	Not connected
5	DGND	P	Ground
6	NC	–	Not connected
7	RS232_RTS	O	Request To Send
8	RS232_CTS	I	Clear To Send
9	NC	–	Not connected
M	DGND	P	Ground

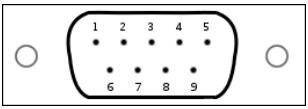

Illustration 16: Wiring of X32B

Attention: Destruction or malfunction!	
	Due to three physically identical 9-pin male D-sub connector plugs there is the danger of confusion between RS232, RS485 and CAN. The exact arrangement of the interfaces is shown in Illustration 2 on page 9.

4.1.3.4 CAN 1/ CAN 2 (X1A)

Table 15: Plug connector CAN 1 and CAN 2 (X1A)

Manufacturer	Description
Yamaichi DDPXR-E9P/E15S-C4N-CT	• Dual Standard D-sub connector plug / socket • Top: 9-pin male connector plug • Bottom: 15-pin female socket • –55 °C to +85 °C

The following table shows the configuration of the plug connector for both CAN interfaces.

Table 16: Pin assignment plug connector CAN 1 and CAN 2 (X1A)

Pin	Signal	Type	Remark
1	CANL_2	I/O	CAN Low-Level I/O of CAN 2 / galvanically separated
2	CANL_1	I/O	CAN Low-Level I/O of CAN 1 / galvanically separated
3	GND_CAN	P	Ground / galvanically separated
4	CANH_2	I/O	CAN High-Level I/O of CAN 2 / galvanically separated
5	NC	–	Not connected
6	NC	–	Not connected
7	CANH_1	I/O	CAN High-Level I/O of CAN 1 / galvanically separated
8	NC	–	Not connected
9	NC	–	Not connected
M	DGND	P	Ground housing

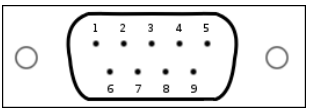

Illustration 17: Wiring of X1A

Attention: Destruction or malfunction!	
	Due to three physically identical 9-pin male D-sub connector plugs there is the danger of confusion between RS232, RS485 and CAN. The exact arrangement of the interfaces is shown in Illustration 2 on page 9.

4.1.3.5 GPIO (X1B)

Table 17: Plug connector GPIO (X1B)

Manufacturer	Description
Yamaichi DDPXR-E9P/E15S-C4N-CT	• Dual Standard D-sub connector plug / socket • Top: 9-pin male connector plug • Bottom: 15-pin female socket • –55 °C to +85 °C

The following table shows the configuration of the plug connector for the GPIOs.

Table 18: Pin assignment plug connector GPIO (X1B)

Pin	Signal	Type	Remark
1	IN0	I	Input 0
2	IN1	I	Input 1
3	IN2	I	Input 2
4	IN3	I	Input 3
5	DGND	P	Ground
6	VCC24V_EX	P	Supply input for the outputs, see Table 6, Electrical characteristics of the GPOs
7	DGND	P	Ground
8	OUT7	O	Output 7
9	OUT6	O	Output 6
10	OUT5	O	Output 5
11	OUT4	O	Output 4
12	OUT3	O	Output 3
13	OUT2	O	Output 2
14	OUT1	O	Output 1
15	OUT0	O	Output 0
M	DGND	P	Ground housing

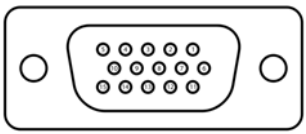

Illustration 18: Wiring of X1B

Attention: Destruction or malfunction!	
	The 15-pin HD-D-sub female socket for GPIO (X1B) looks like a VGA-monitor output. No monitor may be connected there!

4.1.3.6 USB 2.0 Hi-Speed host (X12A)

Table 19: Plug connector USB host (X12A)

Manufacturer	Description
Yamaichi USB-A-002A	• Dual USB jack, type A • U_N = 30 V AC (rms) / I_N = 1 A • U_{max} = 500 V AC for 1 minute • –55 °C to +85 °C

The following table shows the configuration of the plug connector for the USB host interface.

Table 20: Pin assignment plug connector USB host (X12A)

Pin	Signal	Type	Remark
1	VBUS	P	5 V supply (current limitation to 0.5 A) / 100 µF
2	DM	I/O	Negative differential data line
3	DP	I/O	Positive differential data line
4	DGND	P	Ground
M	DGND	P	Ground housing

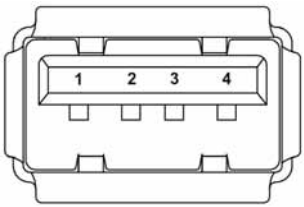

Illustration 19: Wiring of X12A

4.1.3.7 USB 2.0 Hi-Speed host (X12B)[3]

Table 21: Plug connector USB (X12B)

Manufacturer	Description
Yamaichi USB-A-002A	• Dual USB jack, type A • U_N = 30 V AC (rms) / I_N = 1 A • U_{max} = 500 V AC for 1 minute • –55 °C to +85 °C

The following table shows the configuration of the plug connector for the USB host interface.

Table 22: Pin assignment plug connector USB host (X12B)

Pin	Signal	Type	Remark
1	VBUS	P	5 V supply (current limitation to 0.5 A) / 100 µF
2	DM	I/O	Negative differential data line
3	DP	I/O	Positive differential data line
4	DGND	P	Ground
M	DGND	P	Ground housing

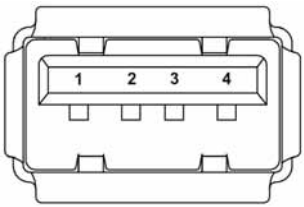

Illustration 20: Wiring of X12B

The USB OTG interface is configured as host by default and cannot be connected to a PC as device. To offer OTG functionality it is possible to provide a USB-Mini-AB jack or Mini-B as a placement option. However, as a result the USB 2.0 Hi Speed interface falls away.

3 It is possible to offer OTG functionality by placement option. The 2.USB then falls away.

4.1.3.8 Audio output right (X27), left (X28)

Table 23: Plug connector audio output right (X27) and left (X28)

Manufacturer	Description
Kycon KLPX-0848A-2-B	• RCA phono jack • U_{max} = 500 V AC for 1 minute • –25 °C to +85 °C

The following table shows the configuration of the plug connectors for the audio-outputs.

Table 24: Pin assignment plug connector audio output right (X27) and left (X28)

Pin	Signal	Type	Remark
1	AGND	P	Ground
2	OUT (R/L)	AO	Analog audio output right / left

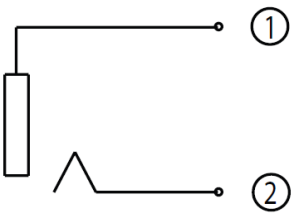

Illustration 21: Wiring of X27 and X28

4.1.3.9 Microphone input (X13)

Table 25: Plug connector microphone (X13)

Manufacturer	Description
Yamaichi AJ330-4T-SMT	• 3.5 mm stereo jack • 5,000 mating cycles • U_{max} = 500 V AC for 1 minute

The following table shows the configuration of the plug connector for the microphone input.

Table 26: Pin assignment plug connector microphone (X13)

Pin	Signal	Type	Remark
1	AGND	P	Ground
2	AGND	P	22 kΩ in series, ground
3	MIC_IN	AI	Analog microphone input
4	NC	–	Not connected

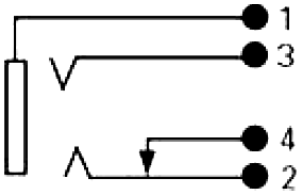

Illustration 22: Wiring of X13

4.1.3.10 SD card (X4)

Table 27: Plug connector SD card (X4)

Manufacturer	Description
Yamaichi FPS009-2405-0	• SD card and MMC reader • 10,000 mating cycles • U_{max} = 500 V AC for 1 minute

The following table shows the configuration of the plug connector for the SD card slot.

Table 28: Pin assignment plug connector SD card (X4)

Pin	Signal	Type	Remark
1	DAT3	I/O	Data line 3, 100 kΩ pull-up
2	CMD	I/O	Command / response Signal
3	DGND	P	Ground
4	VCC3V3	P	3.3 V supply
5	CLK	I	Clock input 50 MHz
6	DGND	P	Ground
7	DAT0	I/O	Data line 0, 100 kΩ pull-up
8	DAT1	I/O	Data line 1, 100 kΩ pull-up
9	DAT2	I/O	Data line 2, 100 kΩ pull-up
CD	CD	I	Card Detect, 10 kΩ pull-up
WP	WP	I	Write Protect, 10 kΩ pull-up
COM	DGND	P	Ground

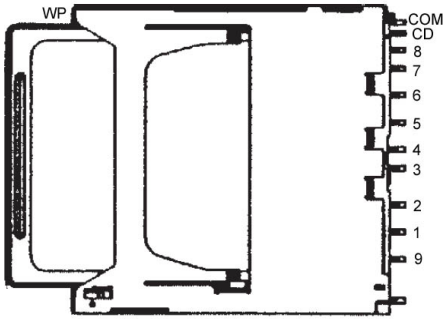

Illustration 23: Wiring of X4

4.1.3.11 Power-in (X6)

Table 29: Plug connector power-in (X6)

Manufacturer	Description
Phoenix Contact MSTBA 2.5/ 2-G-5.08	• Basic package • 5.08 mm pitch • 2-pin • U_N = 250 V / I_N = 12 A

The following table shows the configuration of the plug connector for the 15–30 V power supply.

Table 30: Pin assignment plug connector power-in (X6)

Pin	Signal	Type	Remark
1	VCC24V	P	Input supply voltage
2	GND	P	Ground

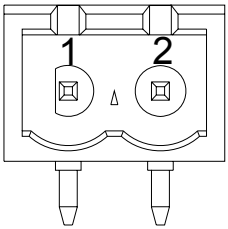

Illustration 24: Wiring of X6

4.2 Internal interfaces

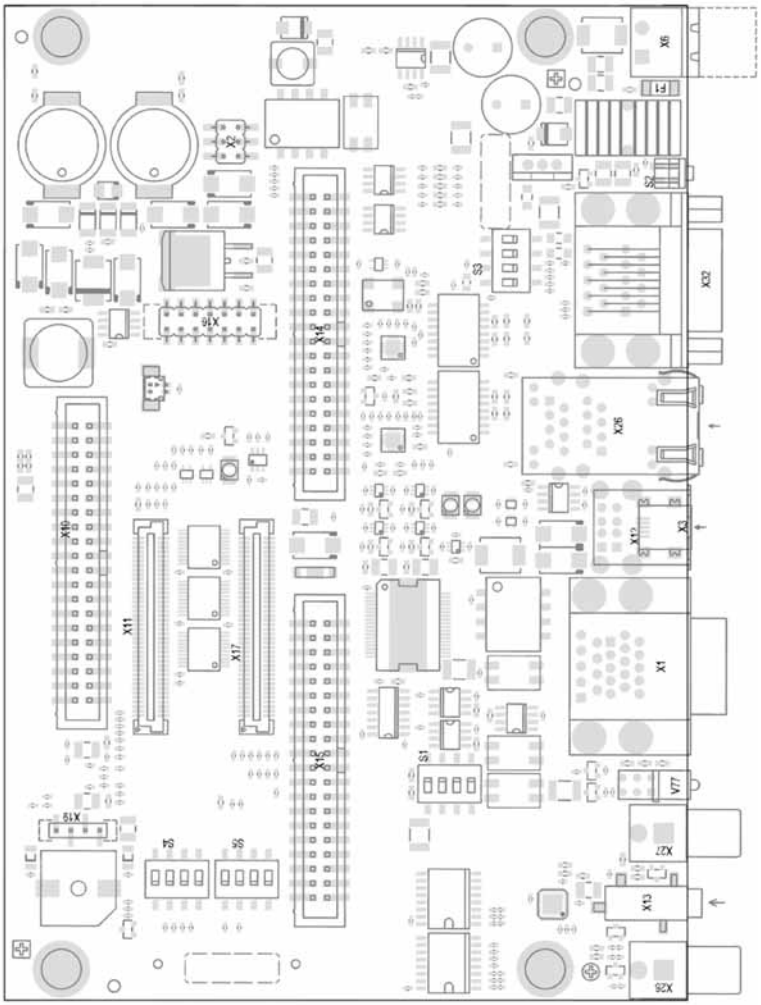

Illustration 25: Internal and external interfaces top side

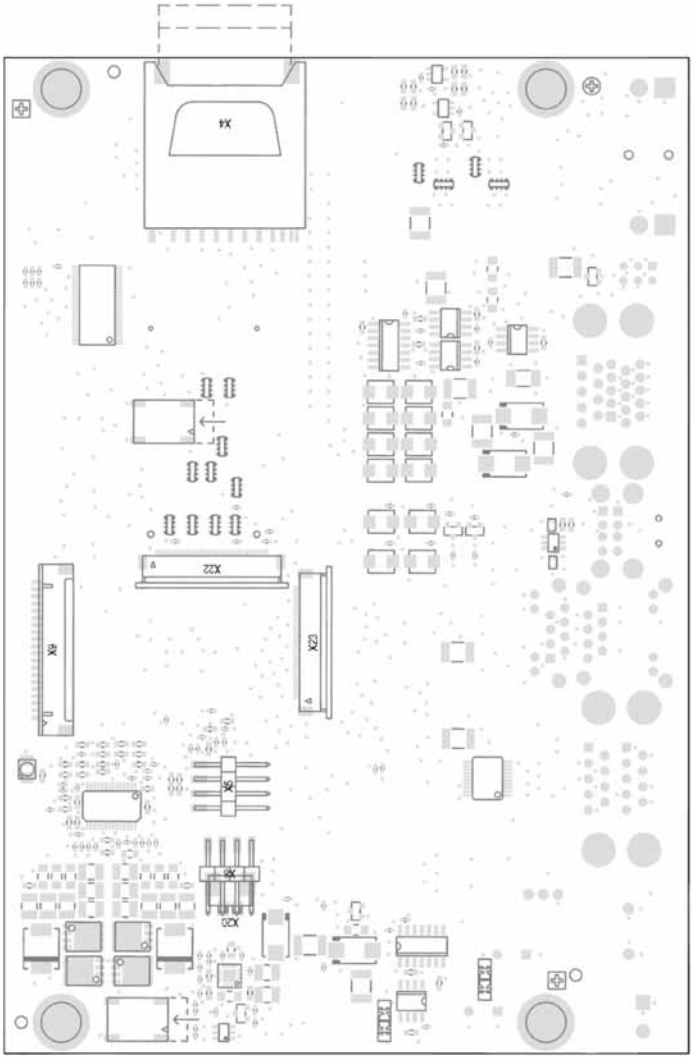

Illustration 26: Internal and external interfaces bottom side

4.2.1 Function specification

4.2.1.1 Module interfaces (X11, X17)

The module interface of the TQMa28 on which the module is plugged consists of two plug connectors.
Plug connector X11 on the STK-MBa28 connects to module plug connector X2 of the TQMa28.
Plug connector X17 on the STK-MBa28 connects to module plug connector X1 of the TQMa28.

Attention: Destruction or malfunction!	
	To avoid damages caused by mechanical stress, the TQMa28 may only be extracted from the base board by using the extraction tool MOZIa28. 2.5 mm should be kept free on the base board, along the longitudinal edges on both sides of the module for the extraction tool MOZIa28.

4.2.1.2 JTAG (X16)

The CPUs' JTAG interface on the TQMa28 is routed directly to a 2.54 mm pitch header on the STK-MBa28.

Attention: Destruction or malfunction!	
	The JTAG signals at the plug connector are directly routed to the CPU. No ESD measures are taken, as it is an internal interface.

4.2.1.3 LCD (X22, X23)

On the STK-MBa28 the LCD bus of the TQMa28 is conditioned by a Texas Instruments driver 74LVC541 and routed to two FFC plug connectors (placement option). For EMC reasons every signal of the LCD bus is terminated with 22 Ω.

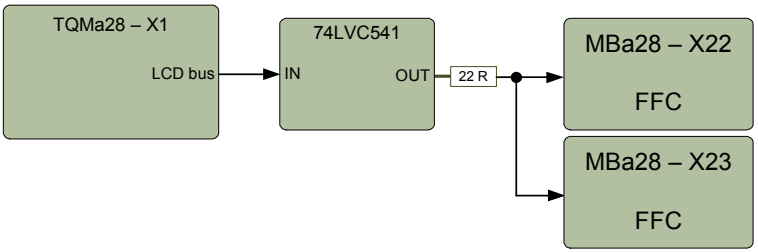

Illustration 27: LCD block diagram

Table 31: LCD bus signals (X22, X23)

LCD bus	16 bit mode	18 bit mode
LCD_D00	B0	B0
LCD_D01	B1	B1
LCD_D02	B2	B2
LCD_D03	B3	B3
LCD_D04	B4	B4
LCD_D05	G0	B5
LCD_D06	G1	G0
LCD_D07	G2	G1
LCD_D08	G3	G2
LCD_D09	G4	G3
LCD_D10	G5	G4
LCD_D11	R0	G5
LCD_D12	R1	R0
LCD_D13	R2	R1
LCD_D14	R3	R2
LCD_D15	R4	R3
LCD_D16	–	R4
LCD_D17	–	R5

4.2.1.4 LCD backlight (X5, X21, X24)

As a placement option the STK-MBa28 offers a driver for displays with LED backlight.
A Linear Technology LT3518 is used for this purpose.
A 12 V supply of up to 2 A, as well as the signals LCD_BKL_ON and LCD_CONTRAST are available at another plug connector.

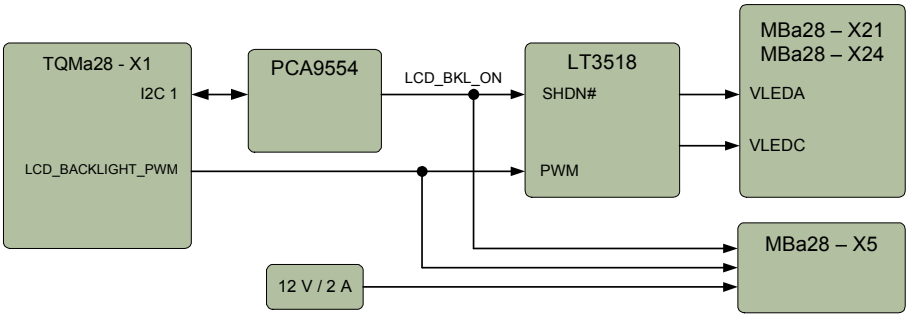

Illustration 28: LCD backlight block diagram

In Table 4 on page 14 the mapping of the signal LCD_BKL_ON is described.

4.2.1.5 Touchscreen (X2, X8, X20)

A touchscreen controller integrated in the i.MX28, which uses the ADC inputs, is made available on the STK-MBa28. This allows connecting 4- or 5-wire touchscreens at the STK-MBa28.
The lines of the touchscreen are equipped with protective ESD diodes, as well as a CLC filter.
Three plug connectors are available:

Table 32: Touchscreen plug connector (X2, X8, X20)

Connector	Type	Pitch / mm	Remark
X2	Header, 2 × 3-pin	2.54	Component side, 4-wire or 5-wire touchscreen
X8	Header, 1 × 4-pin	2.54	Soldering side, 4-wire touchscreen (optional)
X20	FFC, 1 × 4-pin	1.25	Soldering side, 4-wire touchscreen

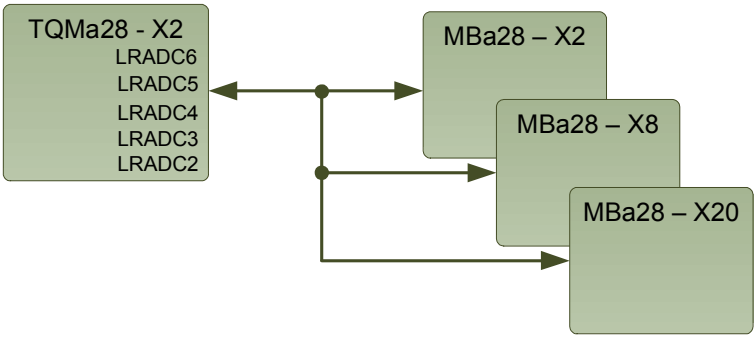

Illustration 29: Touchscreen block diagram

4.2.1.6 LVDS display (X9)

An LVDS transmitter, which transforms the data signals of the LCD bus to LVDS level, is implemented on the STK-MBa28 as a placement option. A Texas Instruments SN75LVDS83B is used for this.

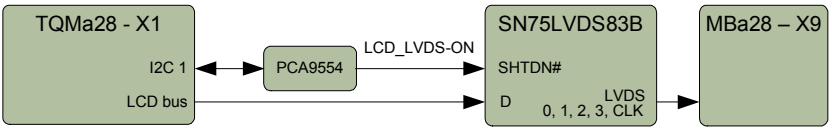

Illustration 30: LVDS display block diagram

Table 33: Allocation of RGB signals on LVDS lines

Input SN75LVDS83B	TQMa28 signal	16 bit mode	18 bit mode	24 bit mode	Remark
D23	–	–	–	–	10 kΩ pull-down
CLKSEL	–	–	–	–	4.7 kΩ pull-down
CLKIN	LCD_DOTCLK	–	–	–	–
D26	LCD_ENABLE	–	–	–	–
D24	LCD_HSYNC	–	–	–	–
D25	LCD_VSYNC	–	–	–	–
D15	LCD_D00	B0	B0	B0	–
D18	LCD_D01	B1	B1	B1	–
D19	LCD_D02	B2	B2	B2	–
D20	LCD_D03	B3	B3	B3	–
D21	LCD_D04	B4	B4	B4	–
D22	LCD_D05	G0	B5	B5	–
D16	LCD_D06	G1	G0	B6	10 kΩ pull-down
D17	LCD_D07	G2	G1	B7	10 kΩ pull-down
D7	LCD_D08	G3	G2	G0	–
D8	LCD_D09	G4	G3	G1	–
D9	LCD_D10	G5	G4	G2	–
D12	LCD_D11	R0	G5	G3	–
D13	LCD_D12	R1	R0	G4	–
D14	LCD_D13	R2	R1	G5	–
D10	LCD_D14	R3	R2	G6	10 kΩ pull-down
D11	LCD_D15	R4	R3	G7	10 kΩ pull-down
D0	LCD_D16	–	R4	R0	–
D1	LCD_D17	–	R5	R1	–
D2	LCD_D18	–	–	R2	–
D3	LCD_D19	–	–	R3	–
D4	LCD_D20	–	–	R4	–
D6	LCD_D21	–	–	R5	–
D27	LCD_D22	–	–	R6	10 kΩ pull-down
D5	LCD_D23	–	–	R7	10 kΩ pull-down

The 10 kΩ pull-down resistors are located at the two most significant bits of RGB. By that they are determined in 18-bit mode. In the i.MX28 Reference Manual the assignment of the RGB signals on the LCD bus of the i.MX28 can be looked up.

4.2.1.7 Power-on (X19)

The PSWITCH-pin of the CPU can be accessed via the power-on interface.

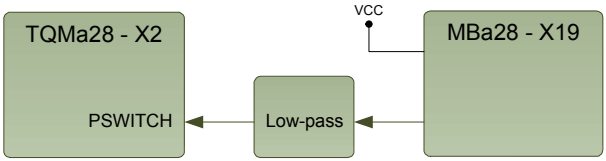

Illustration 31: Power-on block diagram

4.2.1.8 Accumulator connector (X7)

A lithium accumulator can be connected at this connector. A battery may not be used.
The TQMa28 contains a charging circuit, which charges the accumulator when the standard power supply (5 V) is connected. The accumulator buffers the TQMa28.

4.2.1.9 Starterkit interfaces (X10, X14, X15)

In order to be able to use all applicable processor signals several headers are assembled on the STK-MBa28 when it is used as a Starterkit.

Attention: Destruction or malfunction!	
	The signals on the Starterkit interfaces are directly routed to the CPU. No ESD measures are taken as these are internal interfaces.

4.2.2 Electrical characteristics

4.2.2.1 Module interface (X11, X17)

Power supply voltage:	5 V
USB pin voltage:	5 V
Signal level voltage:	3.3 V

4.2.2.2 Power-on

PSWITCH:	See (2)

4.2.2.3 Accumulator connector (X7)

Final charging voltage:	Max. 4.2 V
Charging current:	Max. 400 mA
Preferred type of accumulator:	Lithium accumulator
Module power consumption:	See (2)

4.2.2.4 JTAG (X16)

Signal level voltage:	3.3 V

More information can be found in (2).

4.2.2.5 LCD (X22, X23)

Type of interface:	RGB, 18 bit
Control signals:	Clock, Data enable
Configuration:	The configuration of the LCD interface can be looked up in the i.MX28 Reference Manual

The following displays are supported by the STK-MBa28:

- PowerView T070W2D2
- Data Image FG0700K5DSSWBG01
- Admatec NLC800T70D480CTMK

4.2.2.6 LCD backlight (X5, X21, X24)

4.2.2.6.1 Backlight power supply (X5)

Type:	Buck-regulator
Voltage:	12 V
$Current_{max}$:	2 A

4.2.2.6.2 LED driver (X21, X24)

Output current:	200 mA (app. 10 V)

The LED driver is designed for the supported displays (Admatec, PowerView).

4.2.2.7 Touchscreen (X2, X8, X20)

Interface on module:	LADC
Interface touchscreen:	4-wire, 5-wire
ESD protection:	±15 kV AD, ±8 kV CD

4.2.2.8 LVDS display (X9)

Type of interface:	LVDS 18 bit / 24 bit
Differential pairs:	3 × data, 1 × clock
Control signals:	Clock, HSYNC, VSYNC, and DRDY
Configuration:	The configuration of the LCD interface can be looked up in the i.MX28 Reference Manual
ESD protection:	±5 kV human body model

4.2.2.9 Starterkit interfaces (X10, X14, X15)

All signals at the Starterkit interfaces are 3.3 V compatible.
More information can be found in (2).

4.2.3 Plug connector and pin assignment

4.2.3.1 Receptacle for module

Table 34: Receptacle for module

Manufacturer	Description
Tyco X11, X17: 5177986-3	• Plug connector 80-pin • Stack height 5 mm • U_{max} = 100 V / I_{max} = 0.5 A • 100 mating cycles

The configuration of the module plug connectors is shown in the following tables. The signal direction is described from the perspective of the TQMa28.

Table 35: Pin assignment STK-MBa28 – TQMa28 (X17 – (X1))

PU/PD on TQMa28	I/O	Level	Usage	i.MX28 pin	Name	Pin		Pin	Name	i.MX28 pin	Usage	Level	I/O	PU/PD on TQMa28
		0V	POWER		GND	1		2	GND		POWER	0V		
	out	3V3	LCD	N1	LCD_DOTCLK	3		4	LCD_VSYNC	L1	LCD	3V3	out	
		0V	POWER		GND	5		6	LCD_HSYNC	M1	LCD	3V3	out	
	out	3V3	LCD	K1	LCD_WR_RWN#	7		8	GND		POWER	0V		
	out	3V3	LCD	M6	LCD_RESET	9		10	LCD_RS	M4	LCD	3V3	out	
	out	3V3	LCD	P4	LCD_RD_E	11		12	LCD_ENABLE	N5	LCD	3V3	out	
	out	3V3	LCD	P5	LCD_CS#	13		14	LCD_D00	K2	LCD	3V3	out	10 kΩ ↑
10 kΩ ↓	out	3V3	LCD	K3	LCD_D01	15		16	LCD_D02	L2	LCD	3V3	out	10 kΩ ↓
10 kΩ ↑	out	3V3	LCD	L3	LCD_D03	17		18	LCD_D04	M2	LCD	3V3	out	10 kΩ ↓
	out	3V3	LCD	M3	LCD_D05	19		20	LCD_D06	N2	LCD	3V3	out	
	out	3V3	LCD	P1	LCD_D07	21		22	LCD_D08	P2	LCD	3V3	out	
	out	3V3	LCD	P3	LCD_D09	23		24	LCD_D10	R1	LCD	3V3	out	
	out	3V3	LCD	R2	LCD_D11	25		26	LCD_D12	T1	LCD	3V3	out	
	out	3V3	LCD	T2	LCD_D13	27		28	LCD_D14	U2	LCD	3V3	out	
	out	3V3	LCD	U3	LCD_D15	29		30	LCD_D16	T3	LCD	3V3	out	
	out	3V3	LCD	R3	LCD_D17	31		32	LCD_D18	U4	LCD	3V3	out	
	out	3V3	LCD	T4	LCD_D19	33		34	LCD_D20	R4	LCD	3V3	out	
	out	3V3	LCD	U5	LCD_D21	35		36	LCD_D22	T5	LCD	3V3	out	
	out	3V3	LCD	R5	LCD_D23	37		38	GPIO0_24	R6	GPIO	3V3	bi	
		5V	POWER		VCC5V	39		40	GPIO0_6	U6	GPIO	3V3	bi	
		5V	POWER		VCC5V	41		42	GPIO0_27	P7	GPIO	3V3	bi	
		0V	POWER		GND	43		44	GPIO0_4	T7	GPIO	3V3	bi	
		0V	POWER		GND	45		46	GPIO3_6	K5	GPIO	3V3	bi	
	bi	3V3	GPIO	N9	GPIO0_17	47		48	GPIO0_26	P6	GPIO	3V3	bi	
	bi	3V3	SD_CARD	U8	SD_D0	49		50	GPIO0_7	T6	GPIO	3V3	bi	
	bi	3V3	SD_CARD	R8	SD_D2	51		52	GPIO0_16	N7	GPIO	3V3	bi	
	bi	3V3	SD_CARD	N8	SD_CMD	53		54	GPIO0_5	R7	GPIO	3V3	bi	
	in	3v3	SD_CARD	L9	SD_WP#	55		56	SD_D1	T8	SD_CARD	3V3	bi	
	out	3V3	SD_CARD	P8	SD_SCK	57		58	SD_D3	U7	SD_CARD	3V3	bi	
	in	3V3	UART1	L4	AUART1_RX	59		60	SD_DETECT#	N6	SD_CARD	3V3	in	
	in	3V3	UART3	M5	AUART3_RX	61		62	AUART1_TX	K4	UART1	3V3	out	
	out	3V3	UART3	K6	AUART3_RTS#	63		64	AUART3_TX	L5	UART3	3V3	out	
	in	3V3	CAN1	M9	CAN1_RX	65		66	AUART3_CTS#	L6	UART3	3V3	in	
	out	3V3	CAN1	M7	CAN1_TX	67		68	PWM4	E10	PWM	3V3	out	
	out	3V3	LCD/PWM	K8	LCD_BACKLIGHT_PWM	69		70	PWM3	E9	PWM	3V3	out	
	out	3V3	DUART	L7	DUART_TX	71		72	DUART_RX	K7	DUART	3V3	in	
10 kΩ ↑	bi	3V3	I2C1	H7	I2C1_SDA	73		74	I2C1_SCL	H6	I2C1	3V3	bi	10 kΩ ↑
	in	3V3	UART0	G5	AUART0_RX	75		76	AUART0_TX	H5	UART0	3V3	out	
	out	3V3	UART0	J7	AUART0_RTS#	77		78	AUART0_CTS#	J6	UART0	3V3	in	
		0V	POWER		GND	79		80	GND		POWER	0V		

Table 36: Pin assignment STK-MBa28 – TQMa28 (X11 – (X2))

PU/PD on TQMa28	I/O	Level	Usage	i.MX28 pin	Name	Pin		Pin	Name	i.MX28 pin	Usage	Level	I/O	PU/PD on TQMa28
		0V	POWER		GND	1		2	GND		POWER	0V		
	out	3V3	1588	B1	1588_Event2_out	3		4	1588_Event2_in	C1	1588	3V3	in	
	out	3V3	1588	D1	1588_Event3_out	5		6	1588_Event3_in	E1	1588	3V3	in	
	in	3V3	UART	C2	AUART4 RX	7		8	AUART4 TX	A2	UART	3V3	out	
	out	3V3	UART	B2	AUART4 RTS#	9		10	AUART4 CTS#	D2	UART	3V3	in	
	out	3V3	SPI	A3	SSP2_SCK	11		12	SSP2_MISO	B3	SPI	3V3	in	
	out	3V3	SPI	C3	SSP2_MOSI	13		14	SSP2_SS0	C4	SPI	3V3	out	
	out	3V3	ENET	F3	ENET_FEC_RESET_B#	15		16	DEBUG	B9	CONFIG	3V3	in	10 kΩ ↑
		0V	POWER		GND	17		18	GND		POWER	0V		
	out	3V3	ENET	G4	ENET_MDC	19		20	ENET_CLK	E2	ENET	3V3	out	
	bi	3V3	ENET	H4	ENET_MDIO	21		22	ENET_INT	E3	ENET	3v3	in	
	in	3V3	ENET0	H1	ENET0_RXD0	23		24	ENET0_TXD0	F1	ENET0	3v3	out	
	in	3V3	ENET0	H2	ENET0_RXD1	25		26	ENET0_TXD1	F2	ENET0	3v3	out	
	in	3V3	ENET0	E4	ENET0_RX_EN	27		28	ENET0_TX_EN	F4	ENET0	3V3	out	
	in	3V3	ENET1	J3	ENET1_RX_EN	29		30	ENET1_TX_EN	J4	ENET1	3V3	out	
	in	3V3	ENET1	J1	ENET1_RXD0	31		32	ENET1_TXD0	G1	ENET1	3V3	out	
	in	3V3	ENET1	J2	ENET1_RXD1	33		34	ENET1_TXD1	G2	ENET1	3V3	out	
		0V	POWER		GND	35		36	GND		POWER	0V		
	out	3V3	USB1	F6	USB_1_PWR_EN#	37		38	USB_1_DM	B8	USB1	5V	bi	
	in	3V3	USB1	D3	USB_1_OVERCURRENT	39		40	USB_1_DP	A8	USB1	5V	bi	
	out	3V3	USB0	F5	USB_0_PWR_EN#	41		42	USB_0_DM	A10	USB0	5V	bi	
	in	3V3	USB0	D4	USB_0_OVERCURRENT	43		44	USB_0_DP	B10	USB0	5V	bi	
		0V	POWER		GND	45		46	GND		POWER	0V		
	in	3V3	USB0	J5	USB_0_ID	47		48	CAN0_RX	L8	CAN0	3V3	in	
	in	3V3	CONFIG	A11	PSWITCH	49		50	CAN0_TX	M8	CAN0	3V3	out	
10 kΩ ↑	bi	3V3	I2C0	C7	I2C0_SCL	51		52	I2C0_SDA	D8	I2C0	3V3	bi	10 kΩ ↑
	out	3V3	SPDIF	D7	SPDIF	53		54	GPIO2_9	D10	GPIO	3V3	bi	
	out	3V3	I2S/AUDIO	E7	SAIF0_SDATA0	55		56	SAIF1_SDATA0	E8	I2S/AUDIO	3V3	in	
	bi	3V3	I2S/AUDIO	F7	SAIF0_BITCLK	57		58	SAIF0_LRCLK	G6	I2S/AUDIO	3V3	bi	
	out	3V3	I2S/AUDIO	G7	SAIF0_MCLK	59		60	RESET#	A14	CONFIG	3V3	in	10 kΩ ↑
		0V	POWER		GND	61		62	GND		POWER	0V		
	in	3V3	Touch/ADC	C14	LRADC6	63		64	HSADC0	B14	ADC	3V3	in	
	in	3V3	Touch/ADC	D13	LDADC4	65		66	LRADC5	D15	Touch/ADC	3V3	in	
	in	3V3	Touch/ADC	C8	LRADC2	67		68	LRADC3	D9	Touch/ADC	3V3	in	
	in	3V3	ADC	C15	LRADC0	69		70	LRADC1	C9	ADC	3V3	in	
10 kΩ ↑	in	3V3	JTAG	D12	JTAG_TMS	71		72	JTAG_TCK	E11	JTAG	3V3	in	10 kΩ ↑
10 kΩ ↑	in	3V3	JTAG	E12	JTAG_TDI	73		74	JTAG_TRST#	D14	JTAG	3V3	in	10 kΩ ↑
		4V2	POWER	A15	Battery	75		76	JTAG_RTCK	E14	JTAG	3V3	out	10 kΩ ↑
		4V2	POWER	A15	Battery	77		78	JTAG_TDO	E13	JTAG	3V3	out	
		0V	POWER		GND	79		80	GND		POWER	0V		

4.2.3.2 JTAG (X16)

Table 37: Plug connector JTAG (X16)

Manufacturer	Description
Samtec, TSM-107-01-L-DV	• Header 2.54 mm • 2 × 7-pin

The following table shows the configuration of the JTAG plug connector.

Table 38: Pin assignment plug connector JTAG (X16)

Remark	Signal	X16		Signal	Remark
	VCC3V3	1	2	DGND	
	JTAG_TRST#	3	4	DGND	
Detachable via 0 Ω	JTAG_TDI	5	6	NC	
Detachable via 0 Ω	JTAG_TMS	7	8	NC	Optional via 0 Ω at MR_RESET#
Detachable via 0 Ω	JTAG_TCK	9	10	NC	
	JTAG_TDO	11	12	NC	
	DEBUG	13	14	NC	Optional via 0 Ω at JTAG_RTCK

Positioning see Illustration 38 on page 61.

4.2.3.3 LCD (X22, X23)

Table 39: Plug connector LCD (X22, X23)

Manufacturer	Description
Yamaichi FPC-98210-4021	• FPC plug connector • 0.5 mm pitch • U_N = 50 V / I_N = 0.5 A • Min. 30 mating cycles • –20 °C to +85 °C

Table 40: Pin assignment plug connector LCD (X22, X23)

PowerView Data Image (X22)	Admatec (X23)	Signal	Type	Remark
1	–	DGND	P	Ground
2	–	DGND	P	Ground
3	–	PowerView: NC Data Image: ADJ	– O	PowerView: 100 kΩ ↓ Data Image: LCD_CONTRAST (PWM)
4	40	PowerView/Admatec: VCC3V3 Data Image: VCC5V	P P	Supply voltage
5	39	PowerView/Admatec: VCC3V3 Data Image: VCC5V	P P	Supply voltage
6	38	PowerView/Admatec: VCC3V3 Data Image: VCC5V	P P	Supply voltage
7	37	VCC3V3	P	Supply voltage
8	–	PowerView: NC Data Image: VCC3V3	– P	PowerView: Not connected Data Image: Supply voltage
9	35	DATA Enable	O	LCD_OE (22 Ω in series)
10	34	DGND	P	Ground
11	32	DGND	P	Ground
12	30	DGND	P	Ground
13	29	Blue 5	O	LCD_D5 (22 Ω in series)
14	28	Blue 4	O	LCD_D4 (22 Ω in series)
15	27	Blue 3	O	LCD_D3 (22 Ω in series)
16	26	DGND	P	Ground
17	25	Blue 2	O	LCD_D2 (22 Ω in series)
18	24	Blue 1	O	LCD_D1 (22 Ω in series)
19	23	Blue 0	O	LCD_D0 (22 Ω in series)
20	22	DGND	P	Ground
21	21	Green 5	O	LCD_D11 (22 Ω in series)
22	20	Green 4	O	LCD_D10 (22 Ω in series)
23	19	Green 3	O	LCD_D9 (22 Ω in series)
24	18	DGND	P	Ground
25	17	Green 2	O	LCD_D8 (22 Ω in series)
26	16	Green 1	O	LCD_D7 (22 Ω in series)
27	15	Green 0	O	LCD_D6 (22 Ω in series)
28	14	DGND	P	Ground
29	13	Red 5	O	LCD_D17 (22 Ω in series)
30	12	Red 4	O	LCD_D16 (22 Ω in series)
31	11	Red 3	O	LCD_D15 (22 Ω in series)
32	10	DGND	P	Ground
33	9	Red 2	O	LCD_D14 (22 Ω in series)
34	8	Red 1	O	LCD_D13 (22 Ω in series)
35	7	Red 0	O	LCD_D12 (22 Ω in series)
36	5	DGND	P	Ground
37	4	DGND	P	Ground
38	3	DCLK	O	LCD_SCLK (22 Ω in series) / 10 pF ↓
39	2	DGND	P	Ground
40	1	DGND	P	Ground
–	6	NC	–	Not connected
–	31	NC	–	Not connected
–	33	NC	–	Not connected
–	36	NC	–	Not connected

4.2.3.4 LCD backlight (X5, X21, X24)

Table 41: Plug connector LCD backlight (X5)

Manufacturer	Description
Harwin M20-8900405	• Header 2.54 mm • 1 × 4-pin • I_N = 3 A • –40 °C to +105 °C

Table 42: Pin assignment plug connector LCD backlight (X5)

Pin	Signal	Type	Remark
1	VCC12V	P	Power supply 12 V, alternatively (placement option) 5 V
2	LCD_BKL_ON	O	GPIO from PCA9554D to switch the backlight
3	LCD_CONTRAST	O	Brightness
4	DGND	P	Ground

Table 43: Plug connector LCD backlight (X21, X24)

Manufacturer	Description
JST SM02B-BHSS-1-TB	• Crimp plug connector • U_N = 1,400 V / I_N = 1 A • –25 °C to +85 °C

Table 44: Pin assignment plug connector LCD backlight (X21, X24)

Pin	Signal	Type	Remark
1	VLEDA	P	Anode of LED backlight
2	VLEDC	P	Cathode of LED backlight

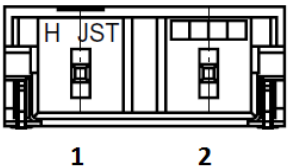

Illustration 32: Pinout of X21, X24

Placement see Illustration 39 on page 62.

4.2.3.5 Touchscreen (X2, X8, X20)

Table 45: Plug connector touchscreen (X2)

Manufacturer	Description
Preferred manufacturer	• Header 2.54 mm • 2 × 3-pin • I_N = 1 A • –40 °C to +105 °C

Table 46: Pin assignment plug connector touchscreen (X2)

Remark	Type	Signal	X2			Signal	Type	Remark
Wire 5	O/P	Touch_Ref_SVB	1		2	Y–	I/P	Input bottom
Input right	I/P	X+	3		4	Y+	I/P	Input top
Input left	I/P	X–	5		6	DGND	P	Ground

Table 47: Plug connector touchscreen (X8)

Manufacturer	Description
Harwin M20-8900405	• Header 2.54 mm • 1 × 4-pin • I_N = 3 A • –40 °C to +105 °C

Table 48: Plug connector touchscreen (X20)

Manufacturer	Description
JST 04FFS-SP-TF	• Plug connector FFC • Pitch 1.25 mm • U_N = 50 V, I_N = 0.5 A • –25 °C to +85 °C

Table 49: Pin assignment plug connector touchscreen (X8, X20)

Pin	Signal	Type	Remark
1	Y–	I/P	Input bottom
2	X+	I/P	Input right
3	Y+	I/P	Input top
4	X–	I/P	Input left

Placement see Illustration 38 and Illustration 39 on pages 61 and 62.

4.2.3.6 LVDS display (X9)

Table 50: Plug connector LVDS display (X9)

Manufacturer	Description
Hirose DF14-20P-1.25H(25)	• Crimp plug connector • U_N = 150 V, I_N = 1 A • –35 °C to +85 °C

Table 51: Pin assignment plug connector LVDS display (X9)

Pin	Signal	Type	Remark
1	DGND	P	Ground
2	DGND	P	Ground
3	LVDS3+	O	Data pair 3 positive
4	LVDS3–	O	Data pair 3 negative
5	DGND	P	Ground
6	LVDSCLK+	O	Clock pair positive
7	LVDSCLK–	O	Clock pair negative
8	DGND	P	Ground
9	LVDS2+	O	Data pair 2 positive
10	LVDS2–	O	Data pair 2 negative
11	DGND	P	Ground
12	LVDS1+	O	Data pair 1 positive
13	LVDS1–	O	Data pair 1 negative
14	DGND	P	Ground
15	LVDS0+	O	Data pair 0 positive
16	LVDS0–	O	Data pair 0 negative
17	DGND	P	Ground
18	DGND	P	Ground
19	VCC3V3	P	Supply voltage 3.3 V, alternatively 5 V
20	VCC3V3	P	Supply voltage 3.3 V, alternatively 5 V

Placement see Illustration 39 on page 62.

4.2.3.7 Power-on (X19)

Table 52: Plug connector power-on (X19)

Manufacturer	Description
Samtec TSM-104-01-LM-SV-P-TR	• Header 2.54 mm • 1 × 4-pin • I_N = 3 A • –55 °C to +125 °C

Table 53: Pin assignment plug connector power-on (X19)

Pin	Signal	Type	Remark
1	WAKEUP#	I	TQMa28 GPIO1_4
2	NC	–	RFU
3	NC	–	RFU
4	RFU	P	Ground

Placement see Illustration 38 on page 61.

4.2.3.8 Accumulator connector (X7)

Attention: Destruction or malfunction!	
	Do not connect a battery, only use lithium accumulators. Reverse polarity of the accumulator can damage or destroy the device. Attention must be paid to the correct polarity of the accumulator!

Table 54: Plug connector accumulator (X7)

Manufacturer	Description
Molex 53398-0271	• Header 1.25 mm • 1 × 2-pin • –40 °C to +85 °C

Table 55: Pin assignment plug connector accumulator (X7)

Pin	Signal	Type	Remark
1	VCC_Battery	P	Accumulator VCC, max. 4.2 V
2	DGND	P	Accumulator Ground

4.2.3.9 Starterkit interfaces (X10, X14, X15)

Almost every signal of the i.MX28 has two or more functions at the Starterkit interfaces.
These can be taken from the i.MX28 Reference Manual.

Attention: TQMa28 pull-up / pull-down resistors	
	The signals at the Starterkit interfaces X10, X14, X15 are directly connected to the module plug connectors of the TQMa28. The pull-up and pull-down resistors on the TQMa28 are shown in Table 35 and Table 36.

4.2.3.9.1 Starterkit interface (X10)

Table 56: Plug connector Starterkit interface (X10)

Manufacturer	Description
Preferred manufacturer	• Header 2.54 mm • 2 × 20-pin • –55 °C to +105 °C

Table 57: Plug connector pin assignment Starterkit interface (X10)

Signal	X10			Signal
DGND	1		2	DGND
1588_EVENT2_OUT	3		4	1588_EVENT2_IN
1588_EVENT3_OUT	5		6	1588_EVENT3_IN
AUART4_RX	7		8	AUART4_TX
AUART4_RTS#	9		10	AUART4_CTS#
SSP2_SCK	11		12	SSP2_MISO
SSP2_MOSI	13		14	SSP2_SS0
CAN0_RX	15		16	I2C0_SDA
CAN0_TX	17		18	I2C0_SCL
SPDIF	19		20	SAIF1_SDATA0
SAIF0_SDATA0	21		22	SAIF0_LRCLK
SAIF0_BITCLK	23		24	SAIF0_MCLK
VCC3V3	25		26	DGND
LRADC6	27		28	HSADC0
LRADC4	29		30	LRADC5
LRADC2	31		32	LRADC3
LRADC0	33		34	LRADC1
VCC5V	35		36	VCC12V
VCC5V	37		38	VCC12V
DGND	39		40	DGND

Placement see Illustration 38 on page 61.

4.2.3.9.2 Starterkit interface (X14)

Table 58: Plug connector Starterkit interface (X14)

Manufacturer	Description
Preferred manufacturer	• Header 2.54 mm • 2 × 20-pin • –55 °C to +105 °C

Table 59: Plug connector pin assignment Starterkit interface (X14)

Signal	X14			Signal
DGND	1		2	DGND
GPIO0_24	3		4	GPIO0_6
GPIO0_27	5		6	GPIO0_4
GPIO3_6	7		8	GPIO0_26
GPIO0_7	9		10	GPIO0_16
LM73_Alarm / GPIO0_5	11		12	GPIO_OVER_TEMP/ GPIO0_17
GND	13		14	GPIO2_9
VCC3V3	15		16	VCC3V3
AUART1_RX	17		18	AUART1_TX
AUART3_RX	19		20	AUART3_TX
AUART3_RTS#	21		22	AUART3_CTS#
CAN1_RX	23		24	CAN1_TX
DGND	25		26	DGND
PWM3	27		28	PWM4
DUART_TX	29		30	LCD_BACKLIGHT_PWM
DGND	31		32	DUART_RX
I2C1_SDA	33		34	I2C1_SCL
VCC3V3	35		36	VCC3V3
DGND	37		38	DGND
DGND	39		40	DGND

Placement see Illustration 38 on page 61.

4.2.3.9.3 Starterkit interface (X15)

Table 60: Plug connector Starterkit interface (X15)

Manufacturer	Description
Preferred manufacturer	• Header 2.54 mm • 2 × 20-pin • –55 °C to +105 °C

Table 61: Plug connector pin assignment Starterkit interface (X15)

Signal	X15			Signal
DGND	1		2	DGND
LCD_DOTCLK	3		4	LCD_VSYNC
DGND	5		6	LCD_HSYNC
LCD_WR_RWN#	7		8	DGND
LCD_RESET	9		10	LCD_RS
LCD_RD_E	11		12	LCD_ENABLE
LCD_CS#	13		14	LCD_D00
LCD_D01	15		16	LCD_D02
LCD_D03	17		18	LCD_D04
LCD_D05	19		20	LCD_D06
LCD_D07	21		22	LCD_D08
LCD_D09	23		24	LCD_D10
LCD_D11	25		26	LCD_D12
LCD_D13	27		28	LCD_D14
LCD_D15	29		30	LCD_D16
LCD_D17	31		32	LCD_D18
LCD_D19	33		34	LCD_D20
LCD_D21	35		36	LCD_D22
LCD_D23	37		38	LCD_BACKLIGHT_PWM
VCC5V	39		40	VCC3V3

Placement see Illustration 38 on page 61.

4.3 User's interfaces

4.3.1 Buzzer (N10)

A GPIO output of the TQMa28 controls the buzzer.
The buzzer is self-excited and does not require a PWM signal.

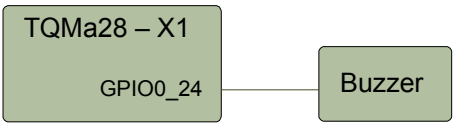

Illustration 33: Buzzer block diagram

4.3.2 Reset push button (S2)

The reset push button resets the CPU on the TQMa28.
As a result the CPU reinitializes all external components.

Table 62: Reset push button (S2)

Manufacturer	Description
Knitter-Switch TMSE 10 J-RA	• Miniature push button • Minimum 100,000 operations • Operating force 3 N ±1 N • Max. 1.27 mm path • –55 °C to +125 °C

4.3.3 Status-LEDs external (V77)

Table 63: External status LEDs (V77)

Manufacturer	Description
VS Optoelectronic WU-2301	• 3-fold LED • Red / yellow / green • 0 °C to +80 °C

Three LEDs are implemented in addition to the status LEDs of both Ethernet jacks.
Their function can be taken from the following table.

Table 64: Overview external LEDs

LED	Colour	Function / display
V77A	Red	User-defined function
V77B	Yellow	User-defined function
V77C	Green	Power-on (voltage regulator indicates power-good)

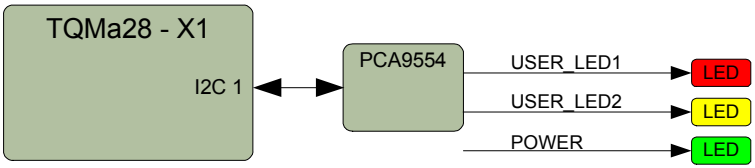

Illustration 34: LED block diagram

For the control of the LEDs see Table 4 on page 14.

4.3.4 Status-LEDs internal (V22, V24, V25, V46)

Internal LEDs are available to display other functions or status messages.
The functions of the LED displays are listed in the following table.

Table 65: Overview internal LEDs

LED	Colour	Function / display
V22	Blue	Power-on (Voltage VCC5V is OK)
V24	Red	Over-current at the USB host interface
V25	Red	Over-current at the USB host interface
V46	Green	Reset to module is active

4.3.5 DIP switches (S1, S3, S4, S5)

Attention: TQMa28 pull-up / pull-down resistors	
	Some signals at the DIP switches S3, S4 and S5 are directly connected to the module plug connectors of the TQMa28. The pull-up and pull-down resistors on the TQMa28 are shown in Table 35 and Table 36.

The STK-MBa28 possesses four DIP switches.
The respective functions are listed in the following tables.

Table 66: DIP switch S1

Switch	ON	OFF (default)
S1-1	Termination CAN1 (120 Ω)	CAN1 not terminated
S1-2	Termination CAN2 (120 Ω)	CAN2 not terminated
S1-3	Slew rate configuration for CAN1 disabled	Slew-Rate can be altered by assembling R282
S1-4	Slew rate configuration for CAN2 disabled	Slew-Rate can be altered by assembling R281

Table 67: DIP switch S3

Switch	ON	OFF (default)
S3-1	No function	No function
S3-2	DEBUG = DGND	DEBUG = TQMa28 pull-up
S3-3	RS485 RxD terminated (120 Ω)	RS485 RxD not terminated
S3-4	RS485 TxD terminated (120 Ω)	RS485 TxD not terminated

Table 68: DIP switch S4

Switch	ON	OFF (default)
S4-1	Boot pin LCD_D04 = 1 kΩ pull-up	Boot pin LCD_D04 = depends on TQMa28
S4-2	Boot pin LCD_D03 = 1 kΩ pull-down	Boot pin LCD_D03 = depends on TQMa28
S4-3	Boot pin LCD_D02 = 1 kΩ pull-up	Boot pin LCD_D02 = depends on TQMa28
S4-4	Boot pin LCD_D01 = 1 kΩ pull-up	Boot pin LCD_D01 = depends on TQMa28

Table 69: DIP switch S5

Switch	ON	OFF (default)
S5-1	Boot pin LCD_D00 = 1 kΩ pull-down	Boot pin LCD_D00 = depends on TQMa28
S5-2	LCD_RS = 1 kΩ pull-up[4], see (1)	LCD_RS undefined
S5-3	No function	No function
S5-4	No function	No function

Table 70: Boot mode options

DIP switch S4				DIP switch S5				Boot from
1	2	3	4	1	2	3	4	
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	eMMC flash on TQMa28
OFF	OFF	OFF	**ON**	**ON**	OFF	OFF	OFF	SD card on STK-MBa28
OFF	**ON**	OFF	OFF	**ON**	OFF	OFF	OFF	(Rescue mode)

4 Activates boot mode configuration by resistors (only necessary when HW_OCOTP_ROM7:0x8002C210:0 = 1)

4.4 System Components

4.4.1 Temperature sensor (D10)

Near plug connector X17 on the top side of the STK-MBa28 is a National Semiconductor LM73 temperature sensor. It can be read out via I2C1.
The base address can be taken from the following table.

4.4.2 I²C address allocation

Table 71: I²C address allocation

I²C bus	Position	Device	Address
1	STK-MBa28	Audio codec – SGTL5000	0x0A
1	STK-MBa28	GPO – PCA9554D	0x20
1	STK-MBa28	GPI, USERLED – PCA9554D	0x21
1	STK-MBa28	Temperature sensor – LM73	0x4A
1	TQMa28	Temperature sensor – LM73	0x49
1	TQMa28	EEPROM – M24C46	0x50

4.4.3 Internal power supply

Table 72: Internal power supply

Voltage	Current
5 V	Max. 4 A
3.3 V	Max. 6 A

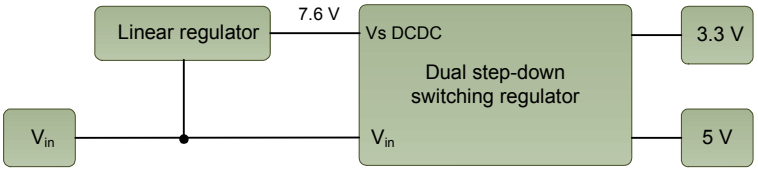

Illustration 35: Internal power supply block diagram

4.4.4 Voltage supervision and reset

The system-reset has four sources:

- Power-on
- Reset push button
- 5 V undervoltage
- 3.3 V undervoltage

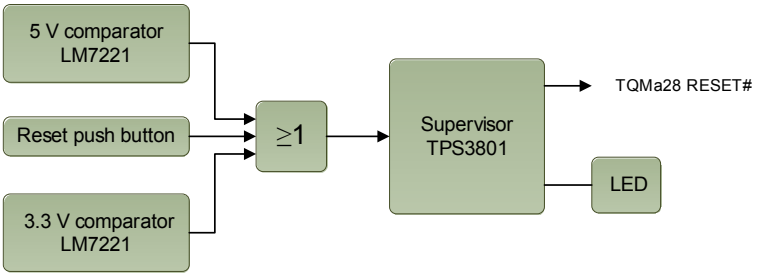

Illustration 36: Voltage supervision / reset block diagram

Table 73: Reset trigger level and voltage supervision

Voltage	Reset trigger level (typical)
5 V	4.58 V
3.3 V	3.14 V

5. SOFTWARE-SPECIFICATION

No software is required for the STK-MBa28.
Suitable software is only required on the module TQMa28 and is not a part of this specification.

6. MECHANICS SPECIFICATION

6.1 Construction

PCB outlines including mounting holes.

6.1.1 PCB outlines STK-MBa28

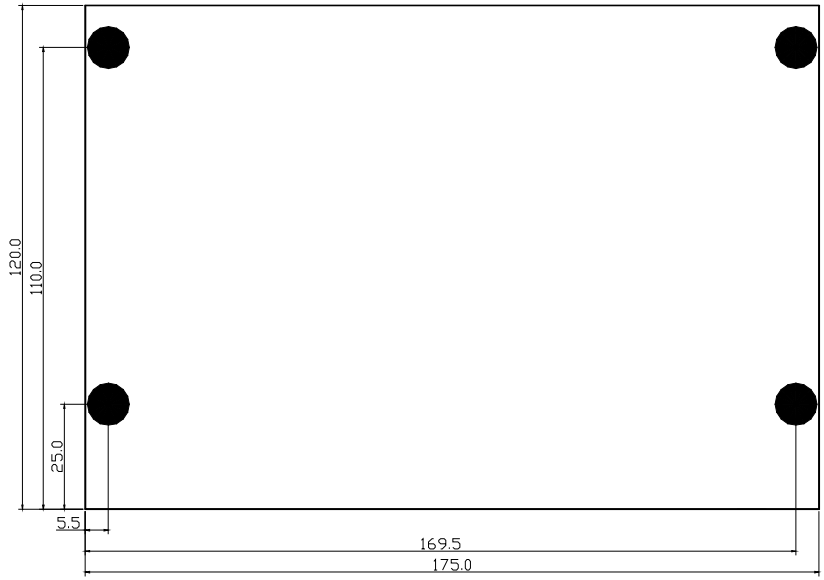

Illustration 37: PCB outlines STK-MBa28

Attention: Destruction or malfunction!	
	To avoid damages caused by mechanical stress, the TQMa28 may only be extracted from the base board by using the extraction tool MOZIa28. 2.5 mm should be kept free on the base board, along the longitudinal edges on both sides of the module for the extraction tool MOZIa28.

6.1.2 STK-MBa28 top view

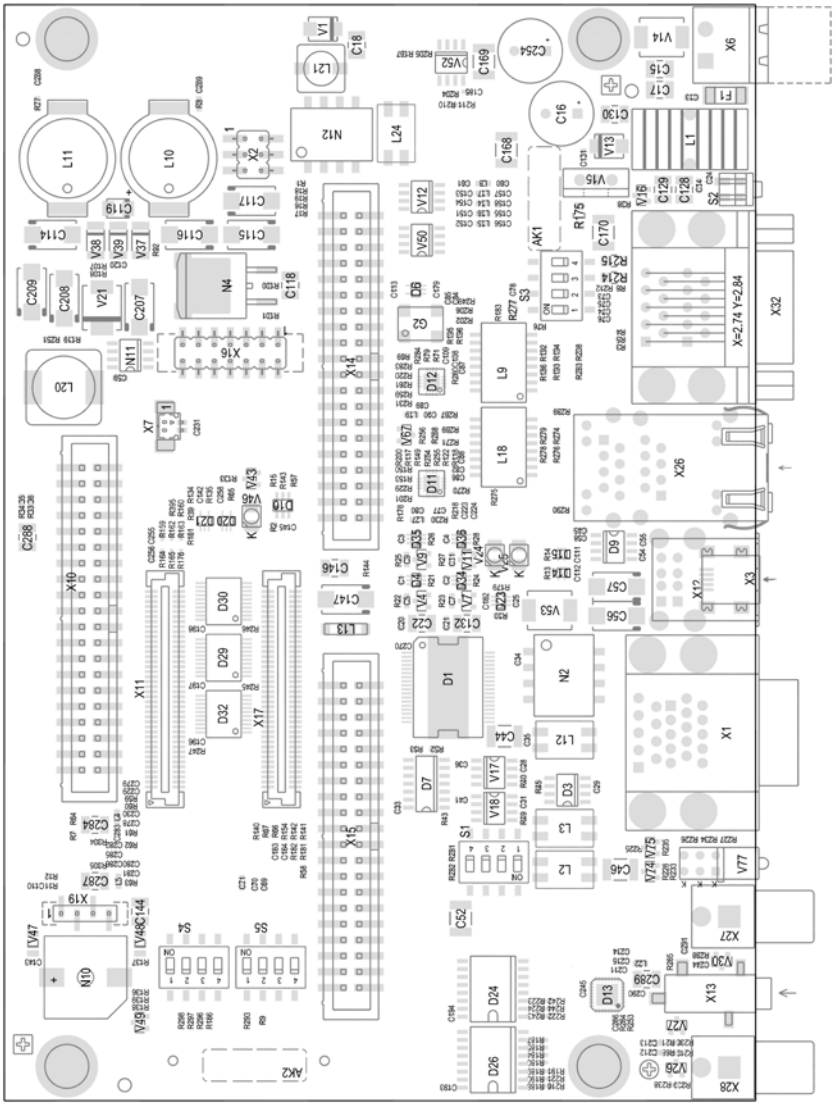

Illustration 38: STK-MBa28 top view

6.1.3 STK-MBa28 bottom view

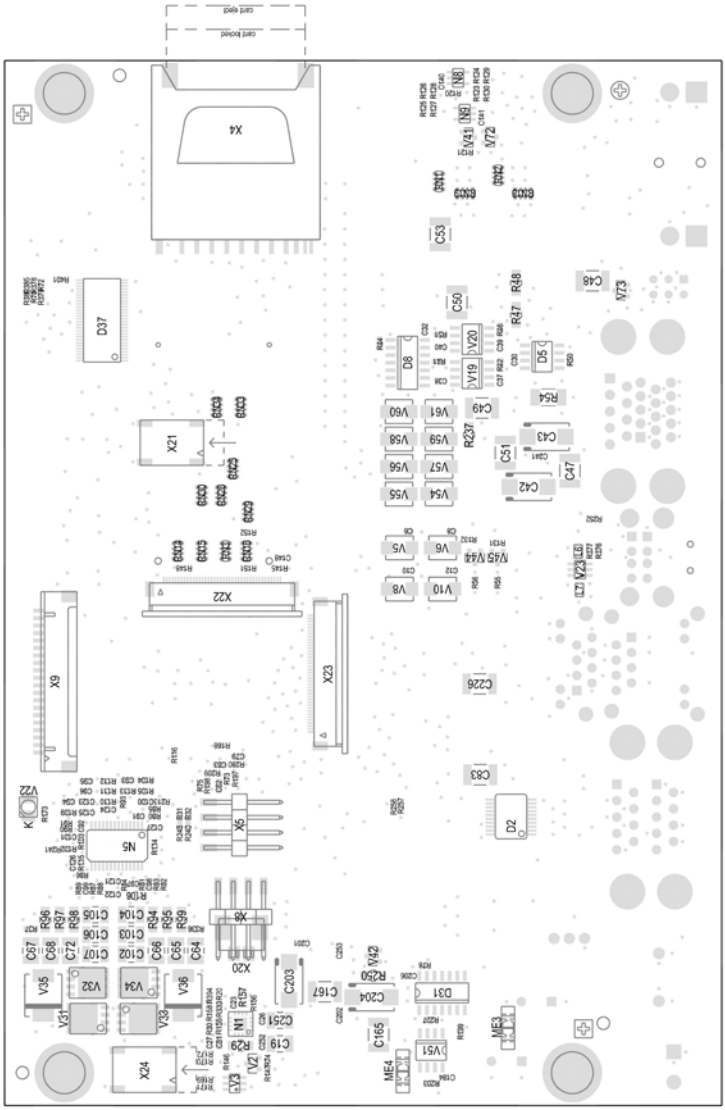

Illustration 39: STK-MBa28 bottom view

6.2 Requirements for the superior system

6.2.1 Protection against external effects

The STK-MBa28 is not protected against dust, external impact and contact (IP00).
An adequate protection has to be guaranteed by the surrounding system.

6.2.2 Thermal management

The main heat source is the TQMa28. Information to the cooling of the TQMa28 is to be taken from his specification.

7. SAFETY REQUIREMENTS AND PROTECTIVE REGULATIONS

7.1 EMC requirements

The assembly TQMa28/STK-MBa28 is EMC tested in a TQ Blue-IPC. Current technical concepts were taken into consideration during the development to avoid or reduce EMC interference. The STK-MBa28 meets the following EMC rules and EMC standards:

- EMC-Interference radiation:
  Measurement of the electrically radiated emission for standard, residential, commercial and light industrial environments in the range of 30 MHz to 1 GHz according to DIN EN 61000-6-3 respective DIN EN 55022.
- EMC-Interference radiation:
  Measurement of the electrically radiated emission for industrial environments in the range of 30 MHz to 1 GHz according to DIN EN 61000-6-4 respective DIN EN 55011.
- EMC-Immunity according to EN 61000-4-2[5]):
  Electrostatic discharge immunity (ESD).
- EMC-Immunity according to EN 61000-4-3[5]):
  Radiated radio frequency, electromagnetic field immunity.
- EMC-Immunity to fast transients according to EN 61000-4-4[5]):
  Electrical fast transient (BURST).
- EMC-Immunity to surge according to EN 61000-4-5[5]):
  Surge immunity test (SURGE).
  In DC networks an inlet length of less than 10 m is assumed.
  For the audit a reference power supply has to be defined / supplied.
  Signal and I/O lines > 30 m must be checked for SURGE.
- EMC-Immunity according to EN 61000-4-6[5]):
  Immunity to conducted disturbances, induced by radio-frequency fields.
- EMC-Immunity according to EN 61000-4-11[5]):
  Immunity to voltage dips, voltage variation and short interruptions in the mains supply (VOLTAGE DIPS).
- EMC-Immunity according to EN 61000-4-29[6]):
  Immunity to voltage dips and short interruptions on the DC input power supply.

7.2 Operational safety and personal security

Due to the occurring voltages (≤36 V DC), tests with respect to the operational and personal safety have not been carried out.

5 The test level and test criteria are taken from the generic standards EN 61000-6-1 and EN 61000-6-2.

6 The test criteria are not fixed here yet, because there are still no generic standards or product standards on which to base this standard. When required the test criteria have to be defined with the customer.

8. CLIMATIC AND OPERATIONAL CONDITIONS

Permitted environmental temperature of all components:	0 °C to +70 °C
Permitted component temperature except SN75LVDS83:	–25 °C to +85 °C
Permitted storage temperature:	–40 °C to +85 °C
Relative air humidity (operation / storing):	10 to 90 % (not condensing)
Protection class:	IP00 (if not mounted in a case)

8.1 Protection against external effects

See section 6.2.1 on page 63.

8.2 Reliability and product life

The device is designed for a typical product life of five years.
Plug connectors of middle grade are used, which guarantee at least 100 mating cycles.

8.3 Displays

The display manufacturers permit a number of pixel defects. These vary depending on the manufacturer and type of display. The permissible error of the pixel display manufacturers (warranty claims) are usually set very high. Pixel errors in the display are allowed by TQ-Systems GmbH.

8.4 Environment protection

By environmentally friendly processes, production equipment and products, we contribute to the protection of our environment.
To be able to reuse the product, it is produced in such a way (a modular construction) that it can be easily repaired and disassembled.
No use of PCB containing capacitors and transformers (**p**oly**c**hlorinated **b**iphenyls).
These points are an essential part of the following laws:

- The law to encourage the circular flow economy and assurance of the environmentally acceptable removal of waste as at 27.9.94
  (source of information: BGBl I 1994, 2705)
- Regulation with respect to the utilization and proof of removal as at 1.9.96
  (source of information: BGBl I 1996, 1382, (1997, 2860)
- Regulation with respect to the avoidance and utilization of packaging waste as at 21.8.98
  (source of information: BGBl I 1998, 2379)
- Regulation with respect to the European Waste Directory as at 1.12.01
  (source of information: BGBl I 2001, 3379)

This information is to be seen as notes.
Tests or certifications were not carried out with respect to that.

8.5 RoHS compliance

The STK-MBa28 is manufactured RoHS compliant. TQ-Systems GmbH issues the RoHS conformity declaration.

8.6 WEEE regulation

TQ-Systems GmbH, which markets the product, is responsible for the observance of the WEEE regulation.

8.7 Accumulator

The lithium accumulator, which is necessary to buffer the RTC, is not in the scope of delivery and must be purchased by the user. For this accumulator the environmental regulations are to be applied accordingly.

9. APPENDIX

9.1 References

Table 74: Further applicable documents

No.	Name	Date	Company
(1)	i.MX28 (MCIMX) Reference Manual (MCIMX28RM)	2010 – Rev. 1	Freescale
(2)	TQMa28.UM.101.pdf	03.11.2011	TQ-Systems

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